.TE OF MONTANA
NATURAL RESOURCE DAMAGE PROGRAM

RESTORATION REPORT
UPPER CLARK FORK RIVER NPL SITES

MARCH 1994

RESTORATION REPORT
FOR THE
UPPER CLARK FORK RIVER BASIN

STATE OF MONTANA
Natural Resource Damage Program
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RESTORATION REPORT
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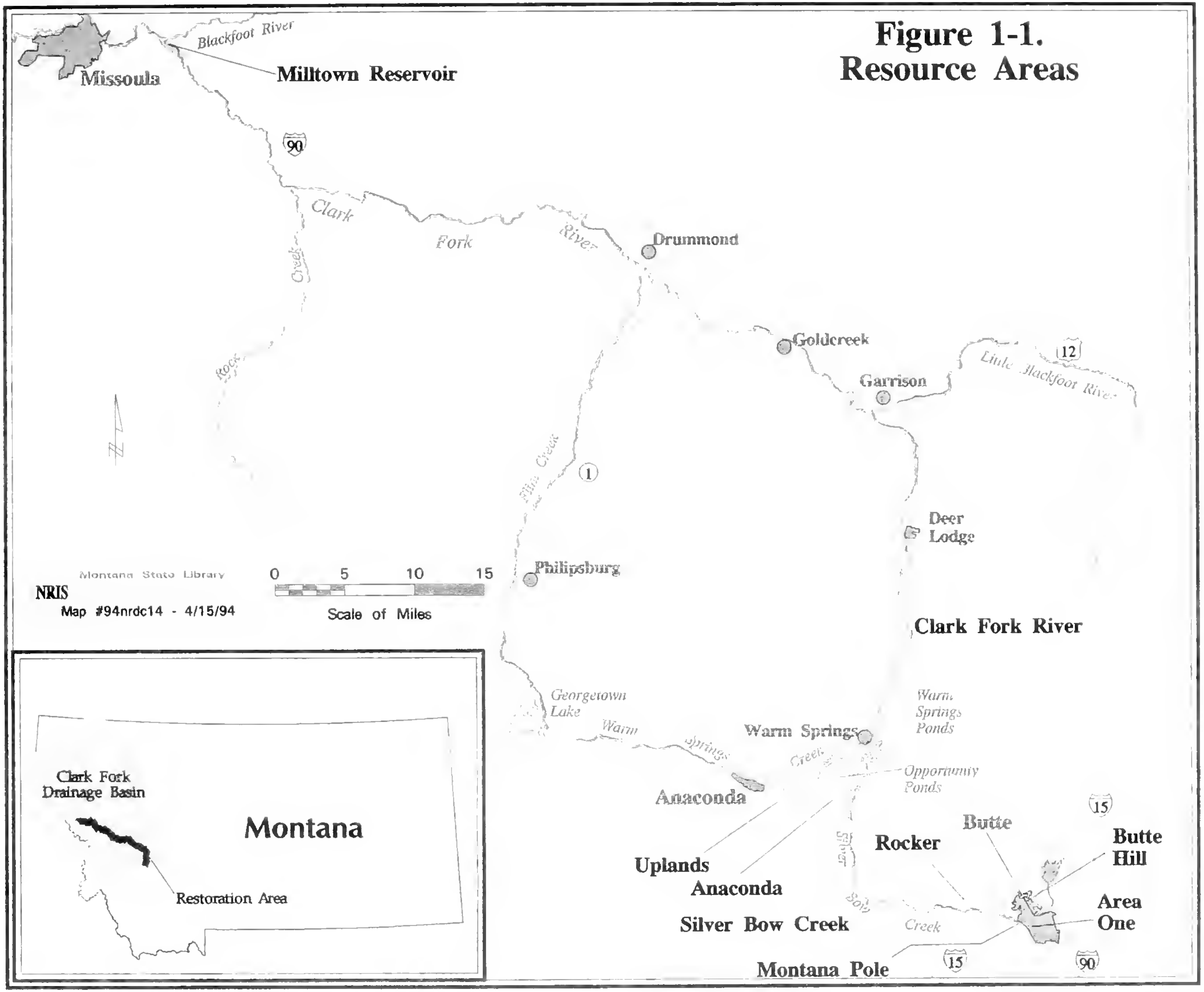


Figure 1-1. Resource Areas

UPPER CLARK FORK RIVER BASIN RESTORATION REPORT

1.0 INTRODUCTION

1.1 Background

This report lists and describes alternatives for the restoration of natural resources in the Upper Clark Fork River Basin. Preparation of the report is pursuant to and in accordance with: 1) the natural resources damage provisions of the Comprehensive Environmental Response, Compensation, and Liability Act, as amended, (CERCLA), 42 U.S.C. §9601 et seq. (otherwise known as Superfund); 2) the Montana Comprehensive Environmental Cleanup and Responsibility Act (CECRA), Mont. Code. Ann. §75-10-701--724 (1993); and 3) the "Natural Resource Damage Assessment" regulations of the Department of the Interior (DOI) (as promulgated and proposed), which implement CERCLA's natural resource damage provisions. 43 C.F.R. §11.

Past mining and mineral processing activities and wood treating operations in the Butte and Anaconda areas by the Atlantic Richfield Company (ARCO) and its predecessors have resulted in widespread injury to natural resources. The U.S. Environmental Protection Agency (EPA) has divided the impacted area into four sites and has placed the sites on the National Priorities List (NPL), which is a list of contaminated sites across the nation most in need of immediate clean-up to "protect the public health or welfare or the environment." 42 U.S.C. §9604(a)(1). These sites are: the Silver Bow Creek/Butte Addition site, the Montana Pole site, the Anaconda Smelter site, and the Milltown Reservoir/Clark Fork River site. Together these sites comprise the largest collection of Superfund sites in the country.

CERCLA and CECRA allow states as trustees for natural resources to recover monetary damages for injuries to natural resources caused by releases of hazardous substances. In 1983 the State of Montana, pursuant to its role as trustee, filed suit against the Atlantic Richfield Company alleging that the company is liable for injury to the natural resources of the Upper Clark Fork River Basin. In the course of this litigation, the State of Montana undertook, through its Natural Resource Damage Program, the preparation of a natural resource damage assessment to document the injury and determine the amount of

damages. The assessment has been conducted in accordance with the DOI regulations.

Assessment activities up to the present include the preparation and release of: 1) a pre-assessment screen, 2) a two-part assessment plan, which included an opportunity for public comment, and 3) three injury assessment reports. The injury assessment reports (incorporated herein by reference)--on aquatic resources, terrestrial resources, including riparian and upland soils, vegetation, wildlife, and wildlife habitat resources, and groundwater resources--demonstrate that mining and mineral processing activities and wood treating operations in the Upper Clark Fork Basin have released "hazardous" and "deleterious" substances as those terms are defined in CERCLA and CECRA; and that these releases have resulted, and continue to result, in severe and widespread injuries to natural resources.

After injuries are demonstrated to exist and are quantified, the natural resource damage assessment regulations require a damage determination in order to "establish the amount of money to be sought in compensation for injury to natural resources resulting from a ... release of a hazardous substance." 43 C.F.R. §11.80(b). There are two parts to a natural resource damage award. First, a trustee can recover compensable value, which DOI identifies as "the value of lost public uses of the services provided by the injured resource, plus lost nonuse values such as option, existence, and bequest values." Proposed 43 C.F.R. §11.83(c)(1). Compensable value was addressed in three reports issued by the State of Montana in December 1993: "Assessment of Damages to Anglers and Other Recreators," "Contingent Valuation of Natural Resource Damage," and "Compensable Natural Resource Damage Determination."

Second, and in addition to compensable value damages, a trustee can also recover damages based on the cost of restoration, rehabilitation, replacement, and/or acquisition of the equivalent of the injured resources (hereinafter collectively termed restoration). This report is specifically concerned with this measure of damages.

As noted above, the various reports already released by the State of Montana, and now this report, have been prepared as part of a natural resource damage assessment in order to provide the factual and legal underpinning for the State's lawsuit against the Atlantic Richfield Company. However, the litigation is stayed while the parties attempt to negotiate a

settlement. Accordingly, at present the reports serve to support the State's claim in the negotiations. If litigation resumes the State will formally release its report of assessment, with modifications, as deemed appropriate, to the reports based on further analysis and consideration. See 11 C.F.R. §11.90.

1.2 Overview

1.2.1 Restoration Generally and the Concept of Baseline

CERCLA makes clear that the purpose of the natural resource damage provisions is to restore injured resources. For example, the statute requires that monies recovered by a trustee be used "only to restore, replace, or acquire the equivalent of such natural resources." 42 U.S.C. §9607(f)(1). Relying on this language the United States Court of Appeals for the District of Columbia Circuit held that restoration costs are the principal measure of damages in a natural resource damage case. State of Ohio v. DOI, 880 F.2d 432 (D.C. Cir. 1989). According to the Court, in fashioning the natural resource damage provisions Congress intended "to effect a 'make whole' remedy of complete restoration." 880 F.2d at 445.

In order to implement the statutory preference for restoration, the DOI regulations utilize the term "baseline," which is defined simply as the condition of the resource had the release of hazardous substances not occurred. 43 C.F.R. §11.14(e). In the usual situation the concept of baseline permits a comparison between a resource's present condition and its condition just prior to the release in question, thus ensuring that liability will only attach to injuries attributable to the release of a hazardous substance. (Present conditions will not be the touchstone in only one circumstance: where a change in the condition of a resource would have occurred in any event and notwithstanding the release of a hazardous substance. In this situation, the change unrelated to the release of a hazardous substance would be taken into account in establishing baseline.) Thus, restoration does not aim to produce a pristine resource, but rather the baseline condition of the resource; in other words, restoration aims to return the resource to the condition it would have been in absent the release of a hazardous substance. Restoration alternatives proposed in this report do not go beyond baseline.

The objective of restoration is to "return to baseline levels both the injured natural

resources and the services that the natural resources provide to the public." 56 Fed. Reg. 19757 (April 29, 1991). In broad terms, a service is any function or utility that one resource provides for another resource or for human beings. Thus, services include "ecological services as flood and erosion control, habitat, and food chains, as well as such human uses as recreation." 51 Fed. Reg. 27679. The ability of a resource "to absorb low levels of [contamination] without exceeding standards or without other effects" is also a service. 51 Fed. Reg. 27716 (Aug. 1, 1986).

Restoration of services is accomplished by restoring resources. DOI has stated, "although it is the natural resource that trustees are restoring, restoration of that resource causes an increase in services. . . ." 58 Fed. Reg. 39340 (July 22, 1993). When services are restored to baseline levels, restoration is deemed complete. Accordingly, this report necessarily focusses on restoring injured resources to baseline conditions. For each proposed alternative, estimates will be provided of when resources, and hence services, will return to baseline levels. Given the severity of the injury to the Basin and the time frames involved, estimates of this nature cannot purport to be exact. The estimates, however, reflect the State of Montana's considered judgment informed by knowledge of the resources and the injuries.

It must be observed that the State of Montana harbors no illusions about what can practically be accomplished in the Upper Clark Fork River Basin given the type and pervasiveness of contamination and the magnitude of the injuries to the State's natural resources. Restoration will be difficult if for no other reason than the fact that metals and metalloids like arsenic, which are responsible for much of the contamination in the Upper Clark Fork River Basin, do not degrade, rather they must be removed, otherwise isolated, or leave the system naturally for injuries to be mitigated. Although it may be possible in some instances for human intervention to restore resources and services to actual baseline levels in years or even decades, for the most part this is not such a case. Generally, the most that can be achieved in the way of restoration of the Upper Clark Fork River Basin in a reasonable time frame is to ameliorate natural resource injuries, enabling the resource and the services provided by the resources to recover substantially.

For each alternative, the report estimates the time frame for substantial recovery. Substantial recovery, as that term is employed here, embodies the State of Montana's

estimation of the length of time for the productivity of the resource, or its ability to provide services, to be greatly enhanced relative to its existing condition. Like estimates of restoration to baseline, estimates of substantial recovery involve uncertainty, depending on difficult projections of effects resulting from various actions.

By making a distinction between restoration to baseline and substantial recovery, the report acknowledges the severity of injury in the Upper Clark Fork River Basin and emphasizes that the extent of injury and inability of human beings to fully redress the injury does not provide an excuse to do nothing. Indeed, actions that improve the condition of the resource, even if not leading directly to restoration to baseline, will accelerate the time of restoration. Natural recovery will be a critical component of every alternative proposed in this report. In the end, baseline will be reached through natural recovery.

1.2.2 Response Actions and the Relationship Between Restoration and Response

While the concept of baseline indicates where restoration stops, it does not aid in determining where restoration actions are to begin. At the Clark Fork River NPL sites various response actions have occurred and will continue to occur. Such actions, directed and ordered by EPA and the Montana Department of Health and Environmental Sciences (MDHES), are not typically undertaken to restore resources, but rather to address any actual or potential threat to public health or the environment. Nonetheless, these response actions tend to mitigate injuries to natural resources. This movement towards a resource's baseline condition must be taken into account during restoration planning. A trustee cannot seek damages to restore what has already been accomplished by response actions. Put another way, natural resource damage restoration can only address those injuries that are residual to, or left over after, response actions.

In order to ensure that the "effects of response actions shall be factored into the analysis of damages," the regulations require that "[i]f response actions will not be completed until after the assessment has been initiated, the anticipated effects of such actions should be included in the assessment." 43 C.F.R. §11.84(c)(2). For this report, it is necessary to anticipate the effects of two kinds of response actions: those that have been selected and those that have not yet been selected. In the former case, effects are anticipated by analyzing the various decisionmaking documents, such as the Record of Decision, to identify what the

response action would achieve and what it would not achieve insofar as injury mitigation is concerned.

In cases where the response action has not yet been selected--and most have not--it is necessary as a threshold matter to make a best estimate of what the response action will be. The effects of the estimated action are then projected. This is done by reviewing pertinent documents, such as Remedial Investigation and Feasibility Studies (RI/FS), which describe the site and detail the response action alternatives, by evaluating the effects or anticipated effects of planned or potential actions at various sites in the Basin, by considering the position of the Atlantic Richfield Company, and by discussing the subject with EPA and MDHES personnel.

At sites where the RI/FS process is ongoing, neither EPA nor MDHES would, or could, state whether any potential response action would or would not be selected. It is possible that the response actions estimated by this report will not be chosen by EPA or MDHES. Nothing in this report should be construed as indicating an opinion by EPA or MDHES concerning the merits of any potential response action or which remedy will be selected.

A further point on the relationship between response actions and restoration planning bears noting. The differing statutory and regulatory schemes under which CERCLA response authorities and natural resource trustees operate create the potential for inconsistent response actions and restoration actions. While a response action at a particular site may meet its goals to protect public health and the environment, a restoration action at the same site may require a different approach than that taken by the response action to meet its goals.

To produce maximum gains to the resource, it would be preferable to mesh response and restoration. This can be achieved only by coordination among the various governmental entities involved--EPA, MDHES, and the Natural Resource Damage Program (NRDP)--and by implementing the response action and the restoration action together.

As a matter of policy, coordinating cleanup actions in the Upper Clark Fork River Basin--be they response or restoration actions--makes good sense. Accordingly, restoration alternatives presented in this report assume that such coordination will occur. Thus, if a restoration action were to take a different approach than a response action, since the

restoration action would accomplish the goals of the response action and then some, the restoration action would be implemented and any conflict avoided.

This is not to say, however, that a restoration action would, by definition, be unacceptable if there was a conflict with a response action. If such an instance arose, despite efforts by response and restoration authorities to avoid such a conflict, the restoration alternative proposing the action would need to be evaluated like any other restoration alternative on a site-specific basis.

The report uses the term "restore" to encompass the range of permissible trustee actions identified by the statute and the regulations, which are restoration, rehabilitation, replacement, and acquisition of the equivalent. In only one instance does the report consider replacement or acquisition of the equivalent alternatives; these alternatives would merely substitute services for those lost, while doing nothing to improve the condition of the injured resource. CERCLA establishes a preference for trustee actions that specifically address the injured resources. Given that alternatives appear to exist that actually improve the condition of injured resources, with one exception, it is not deemed appropriate or reasonable at present to evaluate various replacement or acquisition alternatives. In the one instance where such an alternative was considered, restoration of the injured resource is not possible.

1.2.3 The Restoration Methodology Process

The proposed regulations state that a trustee is to consider a reasonable number of methodologies or alternatives that will restore the injured resources. Proposed 43 C.F.R. §11.81(a). The trustee is advised to select a full spectrum of alternatives for restoring a resource. This means that the trustee might consider an alternative that returns the resource and its services to baseline conditions as soon as possible, as well as the alternative of no-action or letting the resource recover naturally. DOI emphasizes, however, that a trustee has broad discretion to decide, based on its expertise, what constitutes a full range of alternatives. 56 Fed. Reg. 19757. And, of course, as in any alternative analysis, only reasonable alternatives need be considered.

When selecting an alternative, a trustee must consider all relevant factors. Such factors include the alternative's technical feasibility, the relationship of the alternative's costs compared to the benefits from implementing the alternative, the alternative's cost-

effectiveness, the effects from response actions, and the ability of the resource to recover with and without restoration. Proposed 43 C.F.R. §11.82(d).

Under the proposed regulations, the arraying, consideration, and selection of alternatives is to be undertaken in one document--the Restoration and Compensation Determination Plan (RCDP). Proposed 43 C.F.R. §11.81. This document is then released for public comment. Comments and responses, along with the RCDP, subsequently become part of the natural resource damage assessment. Proposed 43 C.F.R. §11.81(d)(3).

However, the State of Montana has determined that it is advisable to identify alternatives and discuss and analyze them prior to undertaking a final evaluation of the alternatives. This is done because a decision on which alternatives to choose for detailed consideration can be the critical aspect of the decisionmaking process. Since the alternatives are compared against each other, which alternatives are chosen for consideration can, in effect, dictate which particular alternative will be selected. In recognition of the importance of the choice of alternatives, the State of Montana has decided to add another step to the process established in the DOI regulations and allow comment from the public, the Atlantic Richfield Company, and other government entities, regarding the restoration alternatives the State is considering.

Accepting comments at the present time does not obviate the need for a formal public comment period in the future. As described above, under the proposed regulations a trustee must afford the public an opportunity to comment on the RCDP. Proposed 43 C.F.R. §11.81(d)(2). Upon release of a document that republishes or deletes alternatives proposed by this report, identifies any new or revised alternatives, considers all relevant factors, and selects the most appropriate alternative, the State of Montana will request public comment in accordance with the proposed regulations.

In fact, public comment has been considered in the preparation of this report. In Part II of the State's Assessment Plan, various cost-estimating methodologies were discussed. Part II of the Assessment Plan was released for public comment on April 24, 1992 and those comments have been considered.

1.3 The Sites

A brief overview of the activities causing injuries to natural resources and a general description of the injuries may be useful at this point. Further description of the sites and the injuries is also provided in the individual resource chapters.

As is well known, extensive copper mining has taken place in Butte, Montana. Beginning in the 1880s, literally thousands of miles of tunnels were dug to access the ore body. In the 1950s, open-pit mining began with the construction of the Berkeley Pit. When mining and the groundwater pumping required for mining ceased, acid-mine drainage occurred. As a result, the Berkeley Pit, abandoned mine tunnels, and surrounding bedrock contain highly contaminated groundwater.

Mineral processing activities and smelting in Butte have resulted in the disposal of large volumes of tailings, process waters, and other waste products. Infiltration of precipitation through tailings, soils contaminated by process water releases and waste products, and groundwater contact with these materials, cause hazardous substances to be transported to groundwater.

These past mining activities and disposal practices in the Butte area have resulted in groundwater injury. Injury is demonstrated by, among other things, the fact that groundwater exceeds state and federal drinking water standards for various substances, including arsenic, copper, zinc, cadmium, and manganese.

Disposal of tailings, process water, and other waste products in the Butte area also cause surface water contamination. This occurs in two ways. First, Butte Hill groundwater that is not captured by the Pit flows off the Hill and discharges to Silver Bow Creek. Thus, contaminated Butte groundwater is a source of contamination for Silver Bow Creek. Second, surface runoff from tailings and waste products transports these materials directly and indirectly to Silver Bow Creek.

A unit of the Silver Bow Creek/Butte Addition NPL site known as Area One demonstrates the complexities of the interactions between various resources. At Area One, buried tailings and waste products at the former site of the Parrott Smelter have contaminated groundwater, which subsequently discharges to Silver Bow Creek. At Lower Area One, tailings and waste products at the former site of the Colorado Smelter and the Butte

Reduction Works are located immediately adjacent to Silver Bow Creek. Groundwater, Silver Bow Creek, and waste materials are intimately related at Lower Area One, causing contaminated groundwater to become contaminated surface water. Also, tailings and waste products in the floodplain are continually being rereleased to Silver Bow Creek as a result of surface runoff and streambank erosion.

This pattern of sources releasing hazardous substances to resources, which in turn become sources that rerelease hazardous substances to other resources is typical. Indeed, this characterization depicts the Upper Clark Fork River Basin--from the upper reaches of the watershed in Butte downstream some 140 miles to Milltown Reservoir.

Silver Bow Creek is contaminated by a number of sources. As discussed above, the Creek receives contaminated Butte groundwater and surface runoff from Butte area sources. In addition, the entire floodplain of Silver Bow Creek is contaminated. Hazardous substances residing in the Creek's floodplain and banks are transported to the Creek from surface runoff and channel erosion. Finally, the bed of the Creek is comprised of contaminated sediments.

Adjacent to Silver Bow Creek are the former sites of the Montana Pole and Treating Plant and the Rocker Timber and Framing Plant. Groundwater and soil contamination have resulted from releases of hazardous substances at these facilities. Contaminated groundwater from the sites migrates to Silver Bow Creek.

Injury to Silver Bow Creek is demonstrated by, among other things, exceedances of water quality standards, the inability of fish to live in the Creek, lack of aquatic diversity, and loss of riparian resources.

Continuing downstream, 22 miles from Butte, Silver Bow Creek ends at Warm Springs Ponds near the town of Anaconda. The Ponds were constructed to settle out the large volumes of contaminated materials transported downstream by Silver Bow Creek. The collection of sediments in the Ponds has resulted in groundwater contamination beneath and around the Ponds.

Mineral processing and smelting operations in the Anaconda area have also caused significant impacts. Airborne emissions from smelting released large volumes of hazardous substances over a wide area. When these substances were deposited on the land surface,

injury to soil, vegetation, wildlife, and wildlife habitat resulted. Operations at Anaconda also produced enormous volumes of tailings, waste water, and waste products generally. These materials were disposed in and around the Anaconda area, most notably at Opportunity Ponds and Anaconda Ponds. As a consequence of this disposal, groundwater in the Anaconda area is contaminated and riparian resources injured.

The Clark Fork River from Warm Springs Ponds to Milltown Reservoir is also contaminated by mining waste. Hazardous substances contained in mining wastes have injured aquatic resources. Floodplain tailings, bed sediments, and poor water quality cause fish populations to be reduced from what they otherwise would be, on average, by a factor of more than three.

Lastly, at Milltown Reservoir sediments transported downriver from upstream sources have accumulated in significant quantities. This has caused the aquifer underlying, and adjacent to, the reservoir to become contaminated.

While the foregoing discussion introduces the Upper Clark Fork River Basin, it also illustrates a critical feature of restoration planning and a relevant factor for restoration decision making. The restoration of one part of the system is likely dependant on some other part of the system. Accordingly, it is necessary when devising alternatives, and it will be necessary when selecting alternatives, to consider systemic effects.

1.4 Report Organization

The report identifies restoration alternatives for nine geographic areas and for four general categories of natural resources. The nine geographic areas are: Butte Hill, Area One, Silver Bow Creek, Montana Pole, Rocker, Smelter Hill Area Uplands, Anaconda Area (including Opportunity Ponds, Anaconda Ponds and Warm Springs Ponds), Clark Fork River, and Milltown Reservoir. The natural resource categories are: aquatic resources (surface water, sediments, and aquatic life); riparian resources (soils, vegetation, wildlife, and wildlife habitat); upland resources (soils, vegetation, wildlife, and wildlife habitat); and groundwater resources.

Each chapter begins with a general description of the specific area and its injuries. Next there is a description of the sources of hazardous substances to the injured resources. For restoration to occur, the sources of hazardous substances must be addressed. Each

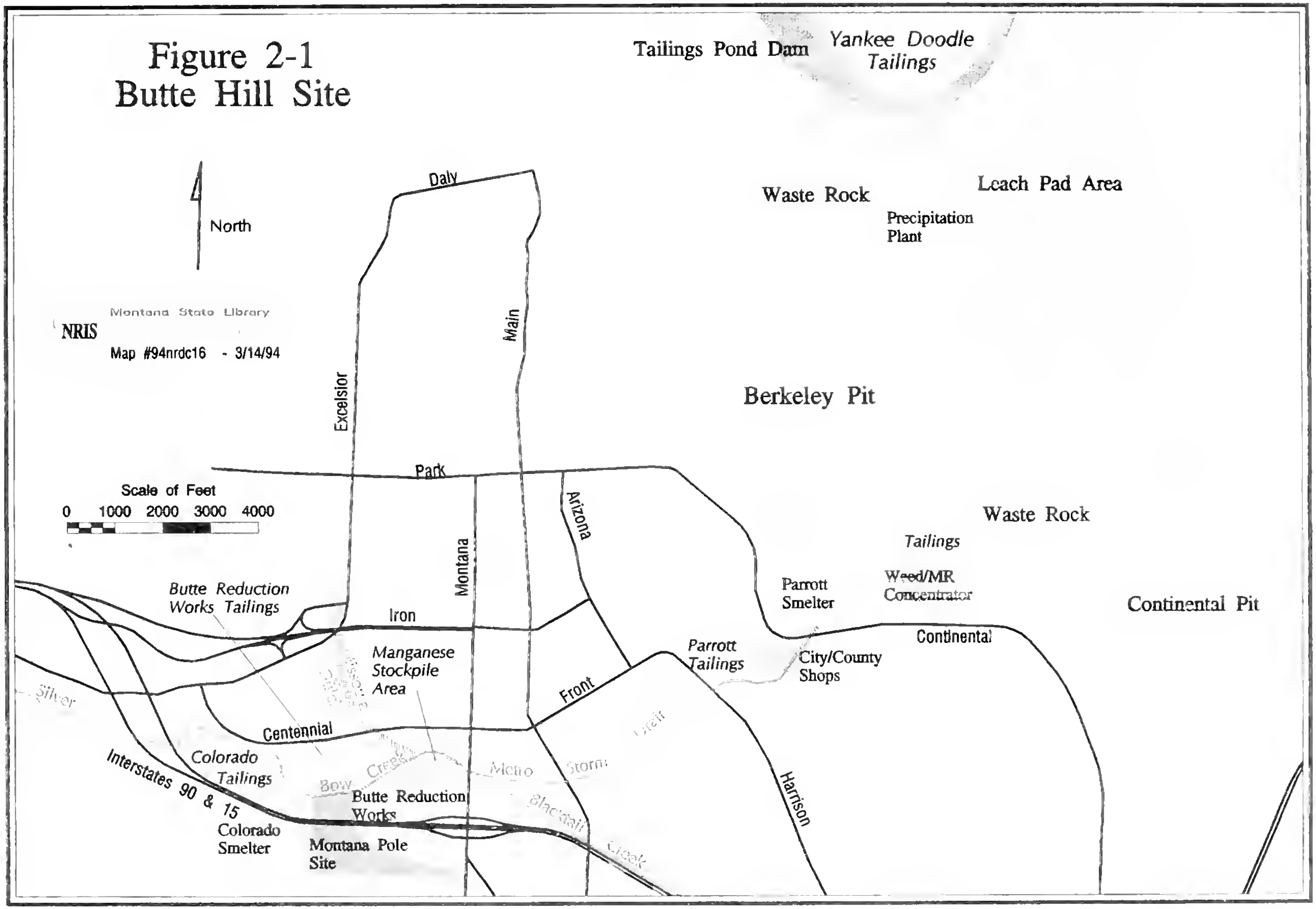
chapter then describes the chosen or anticipated response action and the residual injury to the resource based on the anticipated effects of the response action.

Next, restoration alternatives are proposed. These alternatives include "actions that are needed to bring the injured resources and their services back to baseline . . . in a relatively short period of time" and "actions combined in a manner that would optimize the recovery of all injured resources and services back to their baseline conditions." 56 Fed. Reg. 19757. The alternative of natural recovery is considered for all resource areas. (The report treats the Milltown Reservoir site differently than the other areas. At Milltown no estimate of remedy is made, and thus no restoration alternatives are identified.)

Each alternative proposed will be described and its effects on injured resources discussed. As mentioned earlier, an estimate will be made for each alternative of when resources and services will be returned to baseline. No alternative is designed to exceed baseline.

Lastly, the appendix of the report will include a series of cost tables for each alternative. Issues specific to the cost tables are discussed in an introductory section to the Appendix and in notes that accompany the tables.

Figure 2-1
Butte Hill Site



2.0 BUTTE HILL GROUNDWATER RESOURCES

2.1 Description of Site and Injury

The Berkeley Pit, the adjoining underground mine workings, and the bedrock and alluvial aquifers on Butte Hill represent one of the most contaminated bodies of water associated with a metals mining facility in the world. Combined, this water body presently contains over 60 billion gallons of contaminated water. Levels of hazardous substances in this contaminated water exceed primary and secondary drinking water standards for numerous metals and other contaminants by several hundred to a thousand fold.

Other significant features of the site include the Yankee Doodle Tailings Pond and Dam, the leach pads north of the pit, and various waste rock dumps. These areas continue to be a source of hazardous substances to groundwater.

Mining, which began before the turn of the century, ultimately resulted in an extensive (about 3,000 miles) network of interconnected subsurface workings (tunnels, shafts, etc.). As the mining progressed in depth, groundwater began to accumulate in the mine workings, having migrated from crevices, cracks and fissures in the bedrock. In order to continue mining it soon became necessary to pump this water from the mine workings. During the later stages of underground mining, groundwater was being pumped (at the Kelly Mine shaft) from the mines at rates as high as 7,000 gallons per minute (gpm), or 10.1 million gallons per day (mgd), or 11,300 acre-feet per year.

In the late 1950s, plugs (bulkheads) were installed in the mines to decrease the flow of groundwater between mine workings. The bulkheads resulted in a division of Butte Hill into hydrologic areas: "East Camp" and "West Camp." The East Camp includes the Berkeley Pit, the Kelley, Anselmo, Belmont, Original, Granite Mountain, Lexington, and Steward mines and associated underground mine workings. The West Camp includes the Travona, Emma, and Ophir mine shafts plus associated underground mine workings.

Open pit mining began at the Berkeley Pit during July of 1955. When mining ceased at the Berkeley Pit in 1982, the bottom of the pit was at an elevation of 4,265 feet above mean sea level (msl). (All elevations cited here are based on USGS datum.) The total depth of the pit, from the bottom to the highest point on the rim, is 1,780 feet; the areal extent of

the pit is approximately 700 acres.

Dewatering the mine workings also kept the pit dewatered. Dewatering, however, ended with the termination of mining in 1982. Consequently, since 1982, as the groundwater has risen toward its pre-mining levels, the pit and mine workings have been filling with contaminated groundwater. The water level in the pit in July 1993 was 5,050 feet, representing a depth of water of 786 feet.

Since the water level in the pit is lower than in the East Camp aquifers which intersect the Berkeley Pit, the groundwater in these aquifers flows towards and into the pit. ARCO studies have indicated that so long as the water level in the East Camp/pit system remains at or below an elevation of 5,410 feet--the "critical water level" (CWL)--the pit and the connected underground workings will serve as a sink and contain Butte Hill's contaminated groundwater. If the water exceeds the CWL, these studies indicate that contaminated groundwater will flow in the aquifer systems away from the pit causing further expansion of the contamination and injury to the Butte ground and surface water systems.[1]

The total volume of injured groundwater in the bedrock aquifer (including the underground workings) is estimated to be 119,000 acre-feet; in addition, there is some 64,000 acre-feet of contaminated water in the Berkeley Pit. When the CWL is reached, the volume of contaminated water in the pit is expected to increase to 194,000 acre-feet; at such time the volume of contaminated groundwater in the bedrock aquifer will have increased to about 150,000 acre-feet. Presently the total volume of injured groundwater in the Butte Hill alluvial aquifer is estimated to be 10,744 acre-feet. The areal extent of the injured groundwater in the bedrock aquifer is about 4,600 acres (7.2 square miles) and the areal extent of the alluvial aquifer is 410 acres.

2.2 Sources of Hazardous Substances

The Berkeley Pit and underground mine workings intersect the alluvial and bedrock aquifers underlying the Butte Hill area and are important sources of contamination of bedrock

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[1] Other experts have opined that groundwater in the alluvial aquifer system may flow away from the pit prior to the CWL being reached. This issue will be addressed during the "Active Mining RI/FS" process.

groundwater. Other sources of contamination for both the bedrock and alluvial aquifers are waste rock, mill tailings, leach pads, leaching solution (with added sulfuric acid), and mill process solutions. Leaching of exposed ore and mine waste, both by circulating groundwater and added sulfuric acid, causes injury to groundwater. Injury is manifested by concentrations of metals and other chemical constituents grossly in excess of drinking water standards. Mining-related processes have resulted in the release of hazardous substances, such as arsenic, beryllium, cadmium, copper, lead, mercury, zinc, sulfuric acid, and sulfides of copper, arsenic, zinc and lead to the groundwater.

The primary mechanism for groundwater contamination in the bedrock aquifer is the leaching of mineralized material, including sulfide minerals and efflorescent salts remaining in underground workings, which generates acid mine drainage. (Acid mine drainage, when circulated in the underground workings and bedrock aquifer dissolves metal sulfides and releases sulfates and metals to the groundwater.)

2.3 CERCLA Response Actions

ARCO is currently subject to the Butte Mine Flooding Operable Unit (BMFOU) administrative order on consent (AO-Docket No. CERCLA VIII-90-09) which requires the water level in the East Camp/pit system to be maintained below the CWL. If the CWL is reached, the pit water must be pumped and treated so that the CWL is not exceeded.

2.3.1 East Camp Remediation

The Feasibility Study for the BMFOU outlined 19 potential remedial alternatives for the East Camp, including the Berkeley Pit. Of the 19 alternatives initially screened for further evaluation, 7 alternatives were retained for more extensive analysis. In January 1994, EPA's proposed remedial plan was released; the plan prefers Alternative 6/7, and the Natural Resource Damage Program (NRDP) identifies this alternative as likely to be implemented. Alternative 6/7 provides for the following activities during three distinct time periods:

1) 1996 to 2005

This time period corresponds to the anticipated period of active mining on Butte Hill. During this period a portion of the in-flow of contaminated water to the pit will be controlled

and limited. Presently Horse Shoe Bend (HSB) water, which originates on the surface from seeps near the toe of the Yankee Doodle Tailings Dam, is routed to the pit and the precipitation plant. This 2.40 mgd of highly contaminated acidic water will instead be pumped to the Yankee Doodle Tailings Pond. There the water will be mixed with high pH (alkaline) tailings slurry from the Concentrator. Lime or other neutralizing agents will be added to precipitate metals in the tailings pond. This will reduce the in-flow of water to the Berkeley Pit from approximately 5.0 mgd to about 3.5 mgd.[2]

2) 2005-2023

This period extends from the time it is anticipated that the active mining will cease until the time that the CWL is reached in the Berkeley Pit. Under Alternatives 6/7, during this period the 2.4 mgd of HSB water would be sent to a primary and polishing treatment plant. It is assumed that the clean treated water (about 1.6 mgd) will be discharged to Silver Bow Creek. The sludge (about .8 mgd) will be disposed of either in the Berkeley Pit (Alternative 6) or at an on-site RCRA Subtitle D facility (Alternative 7). It is estimated that this reduction of in-flow to the pit will delay the date at which the CWL will be reached until the year 2023.

3) 2023 and thereafter

After the CWL is reached, presumedly in the year 2023, remediation activities will center on treating the contaminated water from HSB and the Berkeley Pit at an expanded treatment plant. Under Alternative 6, this would amount to about 8.5 mgd. The effluent (about 5.8 mgd of clean water, and about 2.7 mgd of sludge) from the treatment system would continue to be discharged as indicated above (i.e., the water to Silver Bow Creek and the sludge to the pit or a Subtitle D facility).

Also, as part of the remediation for the East Camp, a comprehensive monitoring

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[2] The estimated groundwater contribution from the bedrock aquifer (both from fractures in the bedrock and from the underground mine workings) to the Berkeley Pit is presently about 2.49 mgd (1,729 gpm or 3.85 cfs). Total inflow to the Berkeley Pit is estimated to be 5.05 mgd (3,507 gpm or 7.82 cfs). The remaining 2.56 mgd (1,778 gpm or 3.96 cfs) of in-flow to the pit includes 1.54 mgd (1,069 gpm or 2.38 cfs) of water from the Horse Shoe Bend area, 0.14 mgd (97 gpm or 0.22 cfs) of tailings slurry from the McQueen Booster Station, 0.58 mgd (401 gpm or 0.89 cfs) of alluvial groundwater and 0.30 mgd (208 gpm or 0.46 cfs) of net precipitation/runoff/evaporation.

program will be instituted and institutional controls will be implemented to restrict access to groundwater within the contaminated aquifers.

2.3.2 West Camp Remediation

The Anaconda Company discontinued dewatering the West Camp mines, via the Emma shaft, in 1965. As a result, the bedrock water level began to rise (to 5,515 ft in the Travona shaft) producing groundwater seeps at the surface and in the basements of houses in Butte. In response, in December 1965 and January 1966, the Anaconda Company drilled and installed "Relief Well No. 21" to alleviate the flooding problem. Well 21 flowed at a rate of about 200 gpm and was discharged into Missoula Gulch for three years. During this time, the groundwater level elevation in the Travona shaft remained at about 5,475 ft. In the spring of 1969, groundwater stopped flowing from Well 21 and the groundwater level in the Travona shaft dropped considerably.

In May 1982, the groundwater level elevation in the Travona shaft was 5,164 ft. In May 1984, groundwater levels in the West Camp system began to rise again. In response to this renewed mine flooding, EPA implemented the Travona Shaft/West Camp System Expedited Response Action ("Travona ERA"). In April 1989, an administrative order on consent (AOC) was entered as Docket No. CERCLA VIII-89-19, which required the pumping of water from the Travona shaft to maintain the groundwater level in the West Camp system below 5,435 ft.

One of the principal purposes of the Travona ERA is to abate the potential for a release of West Camp groundwater, which exceeds water quality criteria for iron, sulfate, and arsenic, into Silver Bow Creek. The 5,435 ft. action level corresponds to the approximate alluvial water level along the creek directly south of Well 21.

In 1989, as part of the Travona ERA, treatability studies were conducted for the purpose of developing a treatment plant for the West Camp water. In late 1989, a pumping and monitoring system was designed, installed, and tested in the Travona shaft. A contract between the PRPs and the Butte/Silver Bow County to allow water to be pumped to the Butte Waste Water Treatment Plant was finalized and pumping began in November of 1989. Under this contract, groundwater is pumped to the treatment plant at about 150 gpm (or

about .22 mgd) during about half of each year. (In other words, to keep the water below the 5,435 ft. critical level it is necessary to pump intermittently; in total, this intermittent pumping amounts to 150 gpm over about 6 months out of each year.) This groundwater is mixed with sewage and subsequently treated at the plant. If the Waste Water Treatment Plant cannot continue to accept this water, it will be necessary to treat the water at a different plant or construct another treatment plant to handle this flow.

2.4 Residual Injury

Presumably pumping and treating the pit water and in-flow will preclude further contamination of the aquifer systems; however, pumping and treating will not address the continued infiltration of contamination from the existing mine tunnels and other surface and subsurface sources, such as old mine dumps, the pit walls, the Yankee Doodle Tailings Pond, and the leach pads.[3] Consequently, groundwater in both the alluvial and bedrock aquifers in the Butte Hill area will continue to be contaminated above drinking water standards by these sources.

2.5 Restoration Alternatives

2.5.1 Introduction

Early analysis of restoration alternatives by NRDP included consideration of backfilling the Berkeley Pit and associated underground workings as a means of approaching baseline conditions. The volume of voids in the underground workings is estimated at 17 million cubic yards. The volume of the Berkeley Pit is some 360 million cubic yards. Tailings could be mixed with three percent sodium sulfate resistant cement and slurried into the underground openings via shafts and drill holes. The Berkeley Pit could be backfilled with a combination of waste rock dumped into the pit and tailings/cement slurried into the pit.

Currently, there is a gross shortage of backfill material in the Butte area to fill the

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[3] Furthermore, there have been a number of studies of the Yankee Doodle Tailings Dam, which, when considered as a whole, are inconclusive as to the seismic safety of the dam. Thus, the State of Montana reserves its rights regarding the potential additional contamination which could be brought about by a dam failure.

mine since the majority of the tailings now lie in the Anaconda area. The primary source of local backfill materials is the Yankee Doodle tailings pond. Thus, the majority of required tailings (350 million cubic yards) would have to be returned to Butte from the Anaconda area. The most likely transport method is to construct a slurry pipeline and pump the slurry to the pit.

Backfilling of the workings would significantly reduce acid mine drainage in the underground mines and the pit by limiting future pyrite oxidation. Technically, however, it would be difficult to assure complete filling. In addition, it would take approximately 20 years to complete this task, at an enormous cost. Consequently, this alternative was rejected for further analysis.

Due to the nature and extent of injury, restoration or even substantial recovery of Butte Hill groundwater is not possible. When actual restoration or rehabilitation is not possible a trustee can consider alternative methods of redressing the injury. Such a method is a replacement option, or the substitution of a resource for the injured resource. Alternative No. 2A is a "replacement" option.

2.5.2 Alternative No. 2A

The private well inventory completed for the BMFOU Remedial Investigation indicates that there are more than 800 private and municipal wells within the BMFOU study area. In the "study subarea," which is defined as the portion of the study area "where wells could potentially be impacted by mine flooding waters," there are 140 wells. Thus, groundwater serves as an important source of water in Butte; furthermore, use of groundwater in Butte would be significantly greater if it were not contaminated. The public, however, is precluded from using the contaminated aquifers and water as a water source.

A groundwater resource is also, in essence, an underground reservoir. Such a reservoir offers a number of services beyond the supply of drinking water; such services include water storage and transport. Such services which were once provided by the Butte Hill bedrock and alluvial aquifers have essentially been lost as a result of the contamination.

Accordingly, this alternative considers the functional replacement of the lost resource and the services which it once provided. It would replace not only the quantity of water that

has been lost, it also would replace the function of the aquifer as a reservoir. New or expanded local reservoirs near Butte would be constructed and filled with water which could be used as a source of domestic and/or irrigation water. Such reservoirs and water could also be used as in-stream flow for fishery enhancement in Silver Bow Creek and the Clark Fork River.

In Montana, including the Butte area, it is relatively common for homeowners to drill domestic wells for their personal supply of water as deep as 500 feet. (The well inventory report in the BMFOU RI/FS indicates that wells in the bedrock at Butte Hill have been yielding as much as 50 gpm.) It is estimated that the volume of the bedrock aquifer, which could otherwise be used for domestic wells, that has been lost through contamination is approximately 20,700 acre feet.[4] In addition, there has been the loss of 10,700 acre-feet of alluvial aquifer on Butte Hill. Thus, this alternative would call for the construction of reservoirs totalling 31,400 acre-feet of storage capacity. In addition, these reservoirs should be supplied over a 29 year period, with 355,000 acre-feet of water, representing the total volume of water which will be lost due to contamination in the bedrock and alluvial aquifers by the time the CWL is reached.

2.5.3 Alternative No. 2B

Under the no action alternative, monitoring of shafts and monitoring wells would be performed to evaluate the natural recovery. No further restoration actions would occur beyond the remedy. The level of water in the Berkeley Pit would be maintained at or below the CWL of 5410 feet. This response action will not restore the resource; in fact, the condition of the resource will get worse. The existing volume of injured groundwater, approximately 194,000 acre-feet, will almost double to 355,000 acre-feet within 30 years. Natural recovery of resources and services to baseline would take thousands of years.

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[4] This value was estimated by multiplying the areal extent of bedrock contamination, times four hundred and fifty feet, times the estimated porosity: 4,600 acres * 500 feet * .01 = 20,700 acre feet. This number, which assumes the top 50 feet would not contain water, is believed to be conservative: The upper portions of the bedrock aquifer should have a higher porosity and it is likely that domestic wells could be drilled deeper than 500 feet.

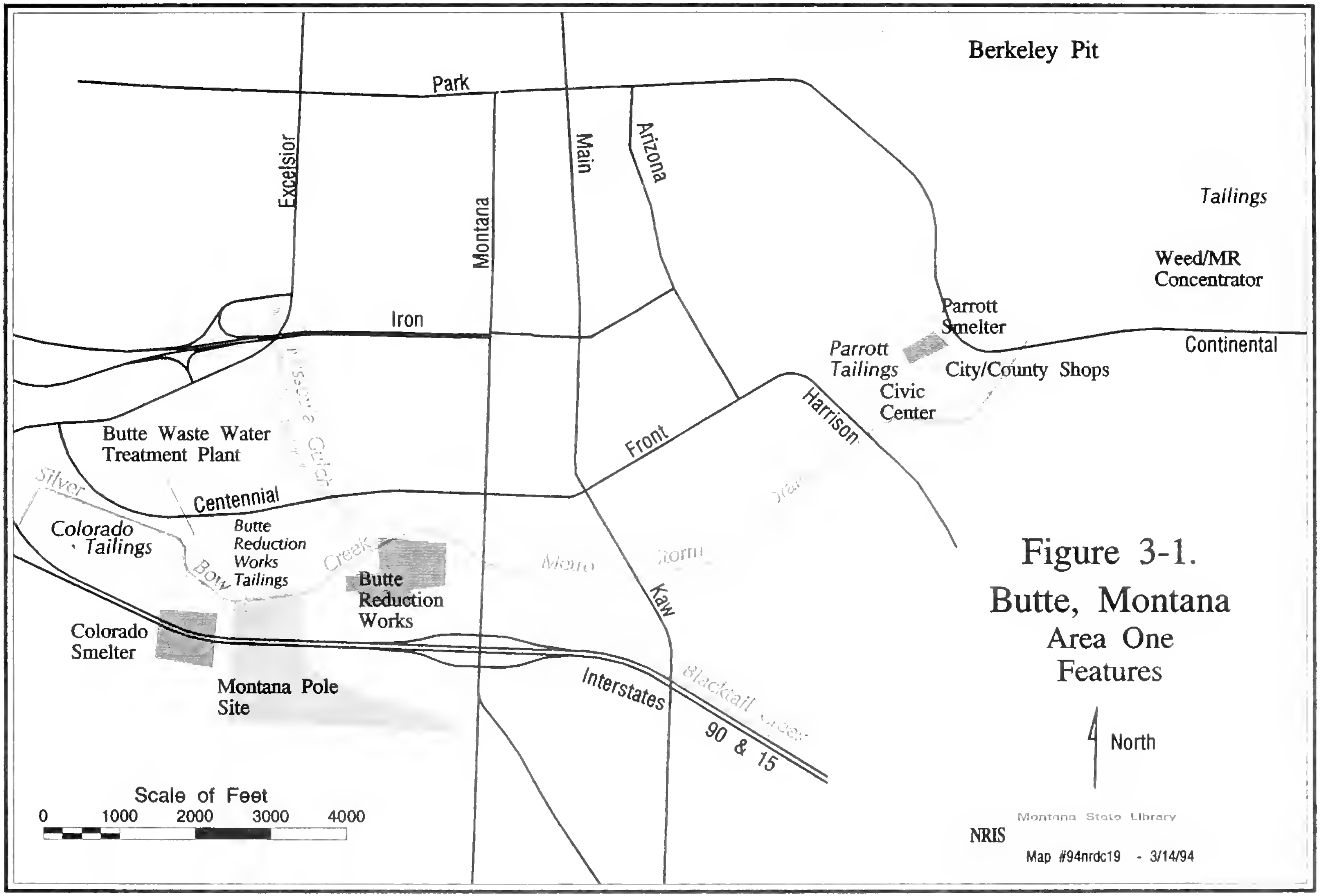


Figure 3-1.
Butte, Montana
Area One
Features

3.0 AREA ONE GROUNDWATER AND SURFACE WATER RESOURCES

3.1 Description of Site and Injury

The deposition of wastes in the city of Butte from mining and mineral-processing operations has resulted in injury to groundwater resources and the surface water resources of Silver Bow Creek. This chapter focuses on Area One, which is part of the Silver Bow Creek/Butte Addition NPL site. Area One extends from the upper end of the Metro Storm Drain (the old Silver Bow Creek channel) to the west end of the Colorado Tailings. The lower Metro Storm Drain extends from Harrison Avenue to Silver Bow Creek. The portion of Area One that contains the Colorado Tailings and the Butte Reduction Works, and the adjacent reach of Silver Bow Creek, is known as Lower Area One (LAO).

The injured aquifers in Butte are a bedrock aquifer underlying Butte Hill, an alluvial aquifer overlying a portion of the Butte Hill bedrock aquifer, and an alluvial aquifer along the Metro Storm Drain and Silver Bow Creek. The Butte Hill bedrock and alluvial aquifers are discussed in Chapter 2. The alluvial aquifer along the Metro Storm Drain and Silver Bow Creek is discussed in this chapter.

Injury to groundwater has been demonstrated by the occurrence of concentrations of heavy metals (including cadmium, zinc, iron, lead, and copper), arsenic, and sulfate that exceed drinking water standards. The areal extent of contamination of the alluvial aquifer is estimated to be 562 acres, based on the size of the largest contaminant plume (sulfate). The total volume of injured groundwater is estimated to be 11,590 acre-feet, and the annual flux (or discharge to Silver Bow Creek) is estimated to be 2,922 acre-feet per year.

Surface waters of Silver Bow Creek are contaminated from the discharge of contaminated groundwater and from surface runoff. Silver Bow Creek is formed by the confluence of Blacktail Creek and the Metro Storm Drain. Blacktail Creek flows year-round and comprises a large part of the flow of Silver Bow Creek. The Metro Storm Drain receives surface runoff during snowmelt and storm events and intercepts contaminated groundwater. Although the Metro Storm Drain contributes much less flow to Silver Bow Creek than does Blacktail Creek, it contributes far more contamination to Silver Bow Creek than does Blacktail Creek. Groundwater in the Metro Storm Drain area flows towards LAO

and discharges, as noted, to the Metro Storm Drain, upper Silver Bow Creek, and possibly Blacktail Creek. Contaminated surface water in Silver Bow Creek flows downstream from Area One and is therefore a source of hazardous substances to injured aquatic resources downstream, which are discussed in Chapter 4.

3.2 Sources of Hazardous Substances

Since the late 1800s, disposal practices from mining and milling operations in Butte have resulted in the presence of tailings and other wastes along the Metro Storm Drain, Silver Bow Creek, and throughout the city of Butte. Much of the waste is associated with three former processing facilities -- the Parrott Smelter, the Butte Reduction Works, and the Colorado Smelter. The Parrott Tailings lie along and northwest of the upper Metro Storm Drain above Harrison Avenue. The Butte Reduction Works tailings and the Colorado Tailings lie adjacent to Silver Bow Creek in LAO. Another tailings deposit probably associated with the Parrott Smelter occurs along the lower Metro Storm Drain between Harrison Avenue and Silver Bow Creek. In addition to these waste sources, dispersed surficial and buried tailings, mine and mill sites, dumps, and contaminated fill areas are located throughout Butte. Another large waste deposit, the Clark Tailings, is located approximately one and one-half miles south of LAO. Because surface water and groundwater contamination from the Clark Tailings is presently under investigation, restoration alternatives presented in this chapter do not address this potential source of contamination to groundwater resources or aquatic resources of Silver Bow Creek.

Groundwater is contaminated in three ways: 1) by the leaching of hazardous substances in the unsaturated zone to downgradient groundwater via infiltration of precipitation or rising capillary groundwater; 2) by the leaching of hazardous substances in the saturated zone via groundwater contact with sources; and 3) by the transport of water containing hazardous substances through the unsaturated or saturated zone to downgradient groundwater.

Surface water contamination results from the discharge of contaminated groundwater and from contaminated surface runoff. Alluvial groundwater discharges to Silver Bow Creek at an average rate of approximately four cubic feet per second (cfs). Surface runoff from storms and snowmelt carries hazardous substances from dispersed waste sources in Butte to

Silver Bow Creek through surface drainages and the Butte stormwater collection system. This runoff, which also transports contaminated sediment, contributes to the contamination of surface water and streambed sediments in Silver Bow Creek.

3.3 CERCLA Response Actions

At the present time, an Expedited Response Action (ERA) is occurring at LAO. Approximately 1.4 million cubic yards of tailings and contaminated soils will be removed from the Butte Reduction Works Tailings and the Colorado Tailings. This volume includes tailings (230,000 cubic yards) and contaminated soils (370,000 cubic yards) at the Colorado Tailings; and tailings (240,000 cubic yards), railroad fill (130,000 cubic yards), and contaminated soils (430,000 cubic yards) at the Butte Reduction Works.

Additional response actions planned or anticipated at Area One are actions that will address contaminated surface runoff to Silver Bow Creek by surface drainages and the stormwater system and actions that will address discharges to Silver Bow Creek of contaminated groundwater. A Record of Decision (ROD) selecting the remedy is anticipated in 1999. Based on a review of the RI/FS literature, an evaluation of actions implemented or planned at other sites in the Basin, consideration of ARCO's position, and discussions with EPA and MDHES personnel, the Natural Resource Damage Program (NRDP) identifies the following actions as likely to be implemented:

1) diverting clean groundwater around the Colorado Tailings site through an interception trench;
2) collecting contaminated groundwater downgradient of the Colorado Tailings, the Butte Wastewater Treatment Plant (WWTP) and slag walls, and the Parrott Tailings;
3) treating 250 to 500 gallons per minute of contaminated groundwater at a lime-precipitation treatment facility at the Colorado Tailings;
4) reconstructing Silver Bow Creek to its approximate historic alignment through the Colorado Tailings area;
5) removing and/or reclaiming waste dumps and mining/milling sites in the uptown Butte area;
6) constructing a stormwater runoff detention basin to intercept and treat surface

runoff from surface drainages and the stormwater collection system;

7) removing and reconstructing the Silver Bow Creek stream channel between the upstream end of the Colorado Tailings and the Metro Storm Drain; and

8) removing 123,000 cubic yards of tailings along the lower Metro Storm Drain between Kaw Avenue and Silver Bow Creek and realigning the Metro Storm Drain within this reach.

The primary objective of remedial actions is to reduce releases of hazardous substances to Silver Bow Creek by intercepting and treating contaminated groundwater and contaminated surface runoff.

3.4 Residual Injury

The remedy will not return injured resources to baseline, nor is it intended to. After implementation of the remedy approximately 800,000 cubic yards of tailings and contaminated soils at the Butte Reduction Works will remain under the Butte WWTP and the slag walls and continue to contaminate groundwater. Approximately 77,000 cubic yards of tailings along the lower Metro Storm Drain and 190,000 cubic yards of the Parrott Tailings will not be removed and will continue to contaminate groundwater. Despite response action efforts at the Colorado Tailings, hazardous substances will remain and continue to contaminate groundwater.

Thus, response actions will not restore groundwater to baseline conditions. It is likely that arsenic, lead, and copper plumes will continue to increase in size. Hazardous substance concentrations will remain well above drinking water standards and baseline conditions.

Tailings removal at LAO will reduce loadings of hazardous substances from groundwater discharge to this reach of Silver Bow Creek by approximately 65 percent. Copper concentrations in Silver Bow Creek will be between 55 and 70 ug/l during base flow, which will exceed both ambient water quality criteria (by a factor of approximately four) and baseline conditions. Additional response actions, in the form of collection systems at various locations that intercept and treat groundwater and surface runoff, will further reduce loadings of hazardous substances to Silver Bow Creek. However, the discharge of contaminated groundwater to Silver Bow Creek will not be eliminated because contaminated groundwater

will continue to discharge directly through the bed of the Creek. Finally, the ubiquitous and widespread extent of surface contamination throughout the Butte area will ensure that surface runoff will transport some amount of contaminated sediment to Silver Bow Creek.

3.5 Restoration Alternatives

3.5.1 Introduction

Distinctions between types of wastes are useful in understanding Area One restoration alternatives. Wastes can be broken into three types: primary sources, secondary sources, and diffuse surface and subsurface sources. Primary sources are directly derived from mining and mineral processing operations. Primary sources include tailings deposits such as the Parrott Tailings. Primary sources contain copper and other metal sulfide mineralization. Secondary sources are derived from the deposition of hazardous substances leached from sulfide minerals in primary sources. Secondary sources include contaminated soils and aquifer materials. Diffuse surface and subsurface sources are largely primary sources. These are scattered throughout Butte and are of an unknown volume and location.

Restoration alternatives do not attempt to address, except indirectly, secondary sources or diffuse sources. There are substantial difficulties associated with removing secondary sources, which can extend to great depths and over large areas of the alluvial aquifer. Removal of diffuse sources is problematic for the obvious reason that their location is not known.

Groundwater restoration can be achieved by removing primary sources and by natural recovery. However, given the widespread extent of diffuse surface and subsurface waste sources, and the extent of secondary contamination of soils and aquifer materials, resources and services will not be restored to baseline conditions for the foreseeable future under any alternative. These diffuse and secondary sources will continue releasing hazardous substances to groundwater for thousands of years. Consequently, restoration alternatives are focussed primarily on improving the condition of the resource and the services it provides relative to its existing condition, and secondarily on accelerating the time frame for restoration.

Although restoration alternatives favor removal actions, consideration was given to other treatment techniques like groundwater flushing or in-situ leaching. But, due to

concerns and uncertainties over the efficacy of such techniques, and given the geochemical characteristics of the sources and the geohydrological characteristics of the site, such techniques were rejected for further analysis at this time.

As discussed in Section 1.2.2, restoration planning will be coordinated, to the maximum possible extent, with response action planning. NRDP will endeavor to implement restoration actions in conjunction with the response action. Such coordination seeks to ensure that restoration actions do not conflict with the chosen response action.

3.5.2 Alternative 3A

This alternative would remove known primary waste sources to reduce releases of hazardous substances to groundwater and surface water. The key elements of this alternative are:

1) excavating tailings beneath the Butte WWTP and the slag walls;
2) excavating the Parrott Tailings;
3) excavating tailings in the lower Metro Storm Drain between Harrison Avenue and Kaw Avenue;
4) disposing of excavated wastes off-site;
5) backfilling excavated areas with clean material;
6) rebuilding the Butte WWTP and the City-County Shop Complex;
7) installing a groundwater interception trench parallel to the lower Metro Storm Drain and Silver Bow Creek to the upstream end of the Colorado Tailings;
8) treating intercepted groundwater at a lime precipitation treatment facility;
9) constructing a sediment detention basin downstream of the Colorado Tailings area; and
10) natural recovery.

All tailings and associated contaminated soils remaining after remedy would be removed. Estimated volumes include 800,000 cubic yards of tailings and contaminated soils beneath the Butte WWTP and the slag walls, 190,000 cubic yards of the Parrott Tailings, and 77,000 cubic yards of tailings in the lower Metro Storm Drain between Harrison Avenue and Kaw Avenue. About 840,000 cubic yards of overburden at the Parrott Tailings and 112,000 cubic yards of overburden in the lower Metro Storm Drain would be excavated,

stockpiled, and backfilled.

To excavate these tailings, it will be necessary to remove the WWTP and the City-County Shop Complex. A new wastewater treatment plant would be sited and built before the existing plant was demolished. Design and construction of the plant would take approximately five years. The City-County Shop Complex could be used while that part of the Parrott Tailings not underlying the Complex was removed. Excavated materials would be disposed of off-site. Excavated areas would be backfilled with the stockpiled overburden and clean material to maintain the existing surface elevation and grade.

A groundwater interception trench would be constructed parallel to the lower Metro Storm Drain and Silver Bow Creek. This trench would intercept contaminated groundwater that would otherwise discharge to Silver Bow Creek by way of the Metro Storm Drain or by way of the streambed.

Intercepted groundwater would be treated at the treatment facility at the lower end of the Colorado Tailings. The 250 to 500 gallons per minute (approximately one-half to one cfs) lime-precipitation facility constructed under remedy would be expanded to treat the additional flow of four cfs. Treated water would be discharged to the headwaters of Silver Bow Creek to maintain instream flows.

A sediment detention basin would be constructed downstream of the Colorado Tailings site. This facility would remove low-level residual concentrations of hazardous substances in surface water and sediments migrating from LAO. The basin would be constructed as two parallel (i.e. side-by-side) cells. This would allow for yearly maintenance of one cell while allowing the second cell to trap contaminated sediment and pass flows from Silver Bow Creek.

Despite the level of effort contemplated by this alternative, Area One resources will not return to baseline conditions solely as a result of the actions planned under this alternative. This is because contamination is extensive and because metals do not degrade.

Impacts to surface water would be significantly reduced under this alternative. Groundwater interception trenches would largely eliminate the discharge of contaminated water to Silver Bow Creek. Furthermore, a large percentage of the contamination that eluded interception would then be removed by the sediment detention basin. Similarly, the

sediment detention basin would address surface water contamination from surface runoff of Butte area sources. However, the sediment detention basin will not remove all contamination migrating downstream.

Groundwater contamination will exist for a significant length of time. As noted, diffuse primary surface and subsurface waste sources are present throughout the Butte area; secondary contamination of soils and aquifer materials is extensive. Natural recovery would be relied upon to decrease loadings from remaining primary and secondary sources and restore resources and services to baseline conditions. Under this alternative, resources and services would not be restored to baseline for a few thousand years.

As a practical matter, however, this alternative would substantially improve the condition of the resource. That is, concentrations of hazardous substances in groundwater would decrease substantially as a result of intensive waste removal. This improvement would be manifested shortly after the excavation of waste sources and constitutes a measure of substantial recovery. Another measure of substantial recovery, which would take much longer to achieve than the initial decrease in contaminant loadings, is the return of at least portions of the contaminated aquifer to drinking water standards. Reduction of contaminant concentrations to drinking water standards might occur within approximately 200 years as natural weathering processes gradually decrease remaining primary and secondary sources of contamination.

3.5.3 Alternative 3B

This alternative focuses on the removal of the most accessible primary waste sources. Waste sources beneath surface facilities and structures would be left in place. The key elements of this alternative are:

1) excavating portions of the Parrott Tailings;
2) excavating tailings in the lower Metro Storm Drain between Harrison Avenue and Kaw Avenue;
3) disposing of excavated wastes off-site;
4) backfilling excavated areas with clean material;
5) installing a groundwater interception trench parallel to the lower Metro Storm Drain and Silver Bow Creek to the upstream end of the Colorado Tailings;

6) treating intercepted groundwater at a lime-precipitation treatment facility;

7) constructing a sediment detention basin downstream of the Colorado Tailings area; and

8) natural recovery.

This alternative differs from Alternative 3A in two respects. First, the Butte Reduction Works tailings underlying the Butte WWTP and the slag walls would be left in place. No further action beyond the response action would address these tailings. Second, only the most accessible area of the Parrott Tailings would be excavated. This area contains some of the thickest deposits of the Parrott Tailings (six feet or more) and is free of surface facilities. This area is roughly nine acres in size and contains approximately 84,000 cubic yards of tailings, which is approximately forty-five percent of the Parrott Tailings.

This alternative reduces impacts to surface water to roughly the same degree as Alternative 3A. Therefore, under this alternative, surface water contamination would be reduced to the same extent and in the same time frame as under Alternative 3A.

Like Alternative 3A, groundwater contamination will exist for a significant length of time. Along with the remaining diffuse primary surface and subsurface wastes and extensive secondary contamination, which are also left in place by Alternative 3A, a significant amount of waste material would be left in place at the Butte Reduction Works and the Parrott Tailings under Alternative 3B. Natural recovery would be relied upon to remove these primary and associated secondary contaminant sources and restore resources and services to baseline conditions. Restoration would take substantially longer under this alternative than under Alternative 3A. With more primary source material remaining under this alternative, more time would be required for oxidation and leaching mechanisms to remove the greater quantity of hazardous substances associated with sulfide minerals. Restoration to baseline would not occur for several thousand years.

However, removal of 45 percent of the Parrott Tailings is expected to result in a substantial improvement in groundwater quality, although not as great as the level of improvement expected under Alternative 3A. The improvement will be manifested shortly after removal. Given the larger volume of primary source material not removed under this alternative as compared to Alternative 3A, it would likely take longer, possibly significantly

longer, to reach drinking water standards than it is projected to take under Alternative 3A.

3.5.4 Alternative 3C

In this alternative, no further action is taken at the site beyond the CERCLA response action. Silver Bow Creek would be a significant source of hazardous substances to resources downstream because contaminated groundwater would continue to discharge to the Creek and because no treatment of surface water, such as utilization of a sediment detention basin, would occur.

Natural weathering processes would be relied upon to restore groundwater to baseline conditions. As described in Section 3.4, groundwater contamination would likely become worse for some period of time as contaminant plumes increase in size. Over thousands of years, contaminant concentrations in groundwater would decrease as leaching mechanisms deplete the supply of hazardous substances in primary sources, namely the Butte Reduction Works, the Metro Storm Drain, and the Parrott Tailings. At this time, contaminant concentrations in groundwater would be reduced to roughly the same level as achieved under Alternative 3A shortly after removal. However under this alternative, as under Alternative 3A, secondary contamination would remain even after primary sources are addressed. Restoration would require another few thousand years to transport secondary source contamination out of the aquifer. Thus, restoration of resources and service flows to baseline would not occur for tens of thousands of years.

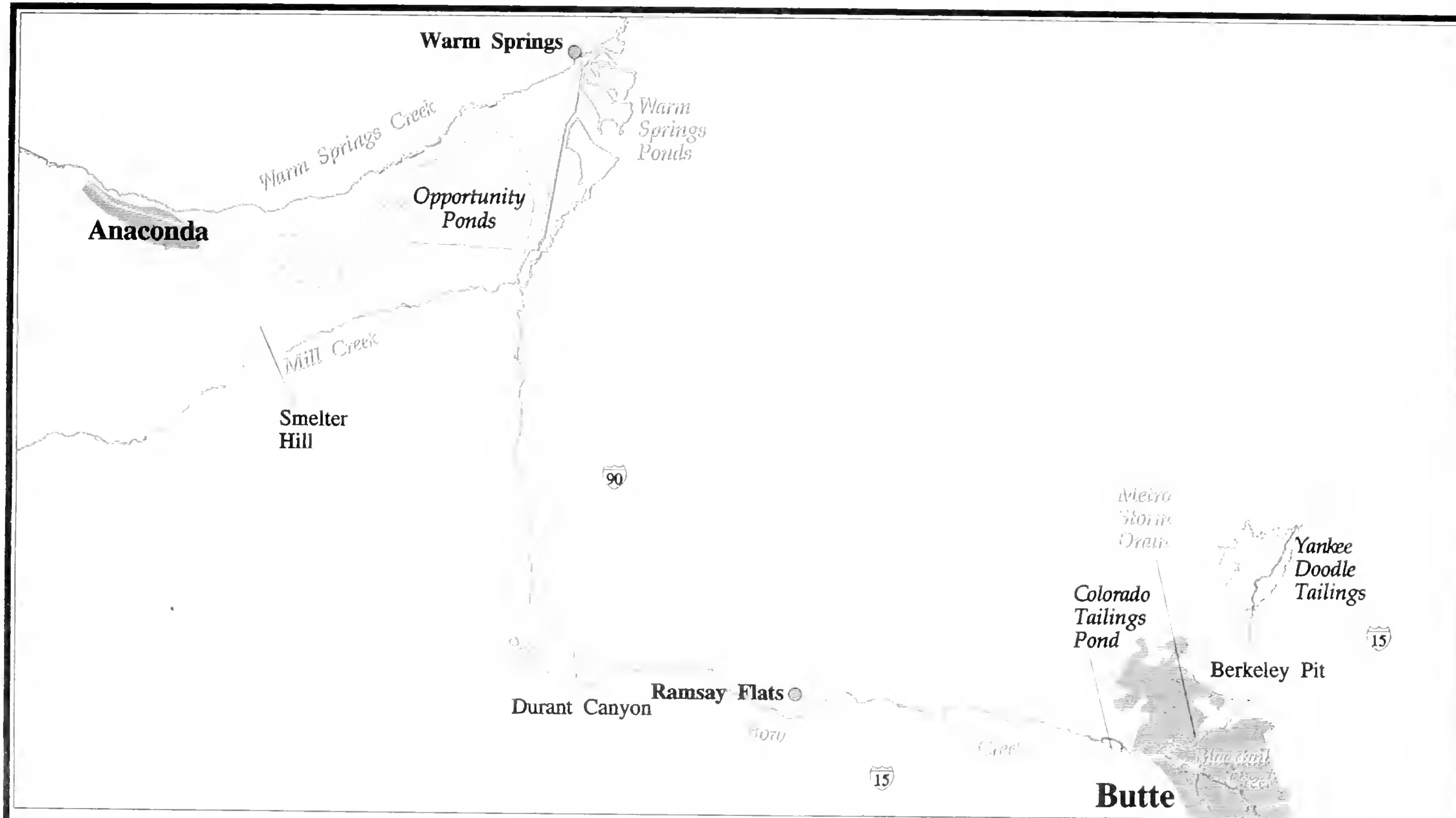


Figure 4-1. Silver Bow Creek

Water Body
Tailings
City

Paved road
Stream

Montana State Library
NRIS
January 1994 - Map Request No: 94NRDC17

0 1 2 3 4 5
Scale of Miles

4.0 SILVER BOW CREEK AQUATIC AND RIPARIAN RESOURCES

4.1 Description of Site and Injury

Aquatic and riparian resources of Silver Bow Creek have been injured by the hazardous substances arsenic, cadmium, copper, lead, and zinc released from mining and mineral-processing operations in the Butte area. Silver Bow Creek is a unit within the Silver Bow Creek/Butte Addition NPL site. As defined here, Silver Bow Creek extends from the lower end of the Colorado Tailings to Warm Springs Ponds--a distance of 22 miles.

Since the late 1800s, tailings and other mining wastes containing hazardous substances have been discharged to Silver Bow Creek. Hazardous substances are pervasive throughout the Silver Bow Creek ecosystem. Natural processes, such as erosion, transport, and redeposition of contaminated materials, ensure that releases of hazardous substances are continuous. The waters of Silver Bow Creek, the limited aquatic life able to survive in the Creek, and the entire floodplain and streambed of the Creek are contaminated.

Natural resource injuries to Silver Bow Creek from releases of hazardous substances include the following:

1) Surface water contains concentrations of hazardous substances that exceed criteria established for the protection of aquatic life and thresholds that have been demonstrated to cause injury to fish.
2) Streambed sediments contain significantly higher concentrations of hazardous substances than exist under baseline conditions and constitute a pathway to benthic macroinvertebrates and fish. For example, copper concentrations are nearly 5,000 times baseline concentrations; cadmium, lead, and zinc are more than 100 times baseline concentrations; and arsenic is roughly 80 times the baseline concentration.
3) The number of benthic macroinvertebrate taxa is significantly reduced relative to baseline conditions. For example, less than one mayfly or stonefly taxa, on average, is found in Silver Bow Creek compared to nine such taxa found under baseline conditions.
4) Fish have been entirely eliminated from Silver Bow Creek. In comparison,

under baseline conditions, Silver Bow Creek would support, on average, over 250 trout per hectare.

5) 1385 acres of Silver Bow Creek's floodplain contains concentrations of hazardous substances that are phytotoxic and lack the capacity to support viable wildlife populations.

6) Populations of otter, mink, and raccoons that rely on fish or benthic macroinvertebrates in their diets have virtually been eliminated from the Silver Bow Creek ecosystem.

For the purposes of this report it is useful to divide Silver Bow Creek into three reaches. These are an 11 mile reach from Colorado Tailings to the top of Durant Canyon, a four mile reach in Durant Canyon, and a 7 mile reach from the bottom of Durant Canyon to Warm Springs Ponds.

The extent of floodplain contamination in each of these reaches reflects the geomorphology of the Creek. Upstream of the canyon and downstream of the canyon, where the floodplain is relatively broad, contamination extends across 569 acres and 768 acres, respectively. In the canyon, where the floodplain is confined, contamination extends across 48 acres.

4.2 <u>Sources of Hazardous Substances</u>

Various waste sources contribute to the injuries in Silver Bow Creek. Sources include those in the Butte area and Area One discussed in Chapter 3. Releases of hazardous substances from the Montana Pole and Treating Plant and the Rocker Timber and Framing Plant are discussed in Chapters 5 and 6, respectively.

Waste sources addressed in this chapter are of two types:

1) tailings and contaminated soils on the floodplain of Silver Bow Creek; and
2) streambed and streambank sediments within the channel of Silver Bow Creek.

Contamination mechanisms include mass wasting, bank erosion and slumping, and surface runoff over tailings. These mechanisms release hazardous substances to surface water and bed sediments. In addition, at high water stage Silver Bow Creek carries increased quantities of contaminated suspended sediments. As high waters recede contaminated material is deposited in bed, bank, and floodplain areas downstream.

An estimated 3,003,000 cubic yards of tailings and contaminated soils cover approximately 1385 acres of the Silver Bow Creek floodplain. Tailings ranging in thickness from a few inches to as much as 6 feet overlie the original floodplain surface. Infiltration of precipitation through tailings has leached hazardous substances to underlying floodplain soils.

The bed of Silver Bow Creek is comprised of contaminated sediment and underlying contaminated alluvial material. Streambed contamination is estimated to be, on average, 2 feet thick. Based on a 22 mile stream length and an average channel width of 20 feet, approximately 172,100 cubic yards of contaminated materials are contained within the Silver Bow Creek streambed.

4.3 CERCLA Response Actions

The Remedial Investigation/Feasibility Study (RI/FS) for Silver Bow Creek is in progress. The RI/FS will evaluate different remedial options for floodplain tailings, including removal with on-site or off-site disposal and in-situ immobilization of hazardous substances by a technique known as STARS (Streambank Tailings and Revegetation Study). STARS entails the addition of lime and other calcium compounds to tailings and contaminated soils and revegetating the amended area with acid and/or metal tolerant plant species, primarily grasses. Lime neutralizes acid pH conditions in tailings and contaminated soils, which immobilizes hazardous substances and permits the reestablishment of vegetation. By these mechanisms STARS seeks to prevent hazardous substances from reaching surface water by runoff or groundwater by leaching.

Based on a review of the RI/FS literature, an evaluation of actions implemented or planned at other sites in the Basin, consideration of ARCO's position, and discussions with EPA and MDHES personnel, the Natural Resource Damage Program (NRDP) identifies the following actions as likely to be implemented at Silver Bow Creek:

1) excavating tailings and contaminated soils within 50 feet on each side of Silver Bow Creek;
2) partially backfilling excavated areas and revegetating primarily with grasses and willows;
3) relocating excavated materials on-site away from the stream channel;
4) treating unexcavated floodplain tailings and contaminated soils and relocated

materials with STARS; and

5) excavating and reconstructing 11 miles of the Silver Bow Creek streambed.

It is estimated that remedy will excavate 50%, or 11 miles, of Silver Bow Creek's streambed. (Stream channel actions are assumed to be evenly distributed over the entire 22 miles of Silver Bow Creek.) As estimated here, the remedy contemplates the excavation of 86,000 cubic yards of contaminated streambed materials.

Floodplain excavation would occur over 133 acres containing 430,200 cubic yards of tailings and contaminated soils from the upper reach of Silver Bow Creek; 48 acres containing 220,000 cubic yards of floodplain material from the canyon reach; and 102 acres containing 330,800 cubic yards of floodplain material from the lower reach. These materials would be relocated on-site away from the stream channel and treated by STARS. A few native grass and shrub species would be planted in excavated areas. The remaining 1102 acres of floodplain containing approximately 2,022,000 cubic yards of floodplain material will be treated by STARS.

4.4 Residual Injury

The remedy will not return the aquatic and riparian resources of Silver Bow Creek to baseline, nor is it intended to. After implementation of the remedy sources of hazardous substances will remain, causing injuries to aquatic and riparian resources.

Reliance on STARS, and the inherent limitations of this method, enables residual injury to riparian resources to occur. Hazardous substances will remain in floodplain tailings and soils at concentrations that will be phytotoxic to many native species. This, and STARS' dependence on acid and/or metals tolerant grass and shrub species for revegetation, will result in poor vegetative diversity and a continuing reduction in wildlife habitat and the number of viable wildlife species over the STARS treated area.

Residual injury to aquatic resources will also occur from extant contamination in 11 miles of unremediated stream channel (bed and banks) and in the STARS-treated floodplain. During storm events, snowmelt runoff, and periods of high and overbank flow, hazardous substances residing in these areas will be eroded and remobilized. When this occurs, surface water concentrations of hazardous substances will exceed aquatic life criteria and baseline conditions. Surface water and bed sediments will remain contaminated and will continue to

expose and injure benthic macroinvertebrates and animals (fish, otter, mink, and raccoons) that consume benthic macroinvertebrates. If Silver Bow Creek is able to support any trout, population levels will be greatly reduced relative to a baseline condition.

Finally, over time stream channel migration will intercept STARS-treated floodplain materials and remobilize hazardous substances, thereby causing additional contamination to streambed sediments and surface water.

An additional concern is the effectiveness of STARS in maintaining a permanent vegetative cover. At the present time NRDP believes there is a risk that over time the neutralization capacity of lime-amended soils will be depleted, causing pH levels to decrease and vegetation to die. In such an event, large areas of revegetated floodplain would revert to the present devegetated condition. Besides the loss of wildlife habitat, hazardous substances would become more available to remobilization by surface runoff and overbank high flows. This would accelerate and exacerbate the contamination of streambed sediments and surface water, which will occur over time in any event, but at a slower rate.

NRDP, MDHES, and EPA are discussing issues related to the effectiveness of STARS. Based on further evaluation of STARS, it is possible that the concerns expressed above regarding residual injury will be alleviated, or that the remedy will utilize STARS in a more restrictive manner than estimated in this report, or that the remedy will not use STARS at all.

4.5 Restoration Alternatives

4.5.1 Introduction

As discussed in Section 1.2.2., restoration planning will be coordinated, to the maximum possible extent, with response action planning. NRDP will endeavor to implement restoration actions in conjunction with the response action. Such coordination seeks to ensure that restoration actions do not conflict with the chosen response action.

In the preceding sections, NRDP estimates that STARS will be a significant part of the remedy at Silver Bow Creek. Since a remedy that utilizes STARS will not result in the restoration of resources and services, alternatives are proposed that would result in the undoing of the remedy (assuming STARS is, in fact, chosen) if STARS is implemented prior to the restoration action. As noted, it is NRDP's intention that such a conflict be avoided by

coordinating with CERCLA response authorities. Accordingly, alternatives presented herein are premised on the assumption that the remedy and the restoration actions are implemented simultaneously and that the remedy will not be undone. However, even if a conflict were to exist between remedy and restoration, the restoration alternatives would be worthy of consideration.

In addition to issues related to STARS, in designing alternatives it was necessary to take into account the widespread and severe nature of the contamination to this riparian ecosystem. To produce benefits to the affected resources and to control migration of hazardous substances to downstream resources, intensive actions such as physical removal of tailings and contaminated soils are required.

4.5.2 Alternative 4A

This alternative would restore aquatic and riparian resources by removing contaminated floodplain tailings and soils and excavating and reconstructing the Silver Bow Creek stream channel. The key elements of this alternative include:

1) excavating 1,102 acres of tailings and contaminated soils within the Silver Bow Creek floodplain;
2) excavating 11 miles of the Silver Bow Creek streambed;
3) disposal of excavated materials out of the floodplain;
4) partial backfilling of excavated floodplain areas with clean fill;
5) covering all excavated areas with six inches of growth media;
6) revegetating excavated areas with native grasses, shrubs, and trees;
7) partial backfilling and reconstructing 11 miles of Silver Bow Creek;
8) constructing sediment detention basins; and
9) natural recovery.

Under this alternative all floodplain tailings and contaminated soils beyond the 50-foot wide strip on each side of the Creek addressed by remedy would be excavated and disposed of off-site. Approximately 2,022,000 cubic yards of tailings and contaminated floodplain soils covering 1102 acres would be excavated. The excavated floodplain would be partially backfilled with clean fill and growth media to create a floodplain contour that would support a baseline habitat mix of shrub/forest and agricultural (hay/pasture) habitat types. Species of

native grasses, shrubs, and trees, along with replanting densities, would be comparable to a baseline condition.

The 11 miles of Silver Bow Creek not excavated under remedy would also be excavated to remove contaminated streambed sediments, underlying alluvial material, and contaminated streambanks. Approximately 86,000 cubic yards of material would be removed from the stream channel based on an 11-mile stream length, an average channel width of 20 feet, and an excavation depth of 2 feet. During stream channel excavation and reconstruction, the flow of Silver Bow Creek would be diverted into a temporary bypass channel or culvert. The stream channel would be reconstructed to its approximate existing alignment. Streambanks would be reconstructed into a variety of slopes representative of baseline conditions and would be configured to provide riparian habitat for wildlife and cover for fish. The excavated streambed would be partially backfilled and reconfigured with channel bedforms (pools, bars, and riffles).

Sediment detention basins would be constructed above and below Durant Canyon to treat residual surface water and bed sediment contamination. The basins would be sized to treat a 100-year flow event.

Notwithstanding the extensive removal actions contemplated by this alternative, residual contamination will persist due to the extent and severity of contamination in the Silver Bow Creek ecosystem. Natural recovery will address this residual contamination. This alternative would restore aquatic and riparian resources and service flows to baseline in approximately 200 years.

Before Silver Bow Creek returns to baseline, substantial recovery will have occurred. Under this alternative Silver Bow Creek will be substantially recovered in 30 years, the length of time required for significant maturation of reestablished streamside vegetation and the reestablishment of a viable salmonid fishery.

4.5.3 <u>Alternative 4B</u>

The focus of this alternative is to address injuries to aquatic resources and enhance near-stream riparian wildlife habitat. The key elements of this alternative include:

1) excavating 436 acres of tailings and contaminated soils within the Silver Bow Creek floodplain;

2) excavating 11 miles of the Silver Bow Creek streambed;

3) disposal of excavated materials outside of the floodplain;

4) partial backfilling of excavated floodplain areas with clean fill;

5) covering excavated areas with six inches of growth media;

6) revegetating excavated areas with native grasses, shrubs, and trees;

7) partial backfilling and reconstructing 11 miles of Silver Bow Creek;

8) constructing sediment detention basins; and

9) natural recovery.

Under this alternative tailings and contaminated soils over the entire floodplain would not be removed, rather an additional 100 feet of floodplain beyond the area excavated under remedy would be excavated to create a remediated zone 300 feet wide. Approximately 1,408,000 cubic yards of tailings and contaminated floodplain soils covering 436 acres would be excavated. The excavated floodplain would be partially backfilled with clean fill and growth media to create a floodplain contour that would reflect a baseline habitat mix of shrub/forest and agricultural (hay/pasture) habitat types. Species of native grasses, shrubs, and trees and replanting densities would be comparable to a baseline condition.

All other elements of this alternative are identical to Alternative 4A.

In this alternative restoration of resources and services to baseline would not occur for centuries. The added length of time to return to baseline for Alternative 4B as opposed to Alternative 4A is attributable to the fact that significantly more contamination is being left in-place under this alternative than Alternative 4A. After implementation of this alternative, 666 acres of floodplain containing 614,000 cubic yards of tailings and contaminated soils treated by STARS under the remedy will be left in place. Natural processes will, over time, remove this contaminated material from the Silver Bow Creek ecosystem.

It is more difficult to assess the time frame for substantial recovery under this alternative. Clearly, the removal of an additional 100 feet of tailings and contaminated soil on each side of the Creek, beyond the 50 foot removal under the remedy, would improve the near-stream riparian environment and buffer Silver Bow Creek from the areas of contaminated floodplain. With successful near-stream revegetation and removal of the remaining 11 miles of stream channel contamination, a fishery and benthic macroinvertebrate

community could substantially recover in approximately the same amount of time as under Alternative 4A. Riparian resources would recover to some degree, though not to the level of recovery under Alternative 4A. In the 666 acres of floodplain that are treated by STARS, the absence of vegetation more reflective of baseline conditions produces less favorable conditions for wildlife than will exist under Alternative 4A.

It should be noted that recovery of aquatic resources under this alternative may well be transient. Given that contaminated floodplain areas will remain a source of hazardous substances to Silver Bow Creek due to natural processes of erosion (snowmelt, storm events, and overbank high-flow events) and stream channel migration, recontamination of the surface waters of Silver Bow Creek and the stream channel will occur over time. The timeframe over which such recontamination occurs, and the degree to which recontamination causes re-injury to aquatic resources, depends on the exact circumstances causing the recontamination. This cannot be predicted with certainty.

Moreover, if STARS is ineffective in maintaining a permanent vegetative cover, hazardous substances in floodplain deposits will be more susceptible to remobilization and migration to Silver Bow Creek and other parts of the floodplain from surface runoff or in the event of an overbank high-flow event or channel migration. Recontamination of excavated floodplain areas could threaten recovered riparian resources.

4.5.4 Alternative 4C

The focus of this alternative is restoration of aquatic and riparian resources in the 11-mile reach of Silver Bow Creek between the Colorado Tailings and Durant Canyon. The key elements of this alternative include:

1) excavating 436 acres of tailings and contaminated soils within the Silver Bow Creek floodplain above Durant Canyon;
2) excavating 5.5 miles of the Silver Bow Creek streambed;
3) disposal of excavated materials outside of the floodplain;
4) partial backfilling of excavated floodplain areas with clean fill;
5) covering excavated areas with six inches of growth media;
6) revegetating excavated areas with native grasses, shrubs, and trees;
7) partial backfilling and reconstructing 5.5 miles of Silver Bow Creek;

8) constructing a sediment detention basin; and

9) natural recovery.

In this alternative all sources of contamination within the floodplain and stream channel of Silver Bow Creek between the Colorado Tailings and the top of Durant Canyon remaining after remedy are removed. Within Durant Canyon and in the lower reach of Silver Bow Creek between Durant Canyon and Warm Springs Ponds, no further actions beyond remedy are undertaken.

Excavation would involve 1,109,800 cubic yards of tailings and contaminated floodplain soils covering 436 acres. The excavated floodplain would be partially backfilled with clean fill and growth media to create a floodplain contour that would reflect a baseline habitat mix of shrub/forest and agricultural (hay/pasture) habitat types. Species of native grasses, shrubs, trees, and replanting densities would be comparable to a baseline condition.

The 5.5 miles of Silver Bow Creek not addressed by remedy would be excavated to remove contaminated streambed sediments, underlying alluvial material, and contaminated streambanks. Approximately 43,000 cubic yards of material would be removed from the stream channel.

A sediment detention basin would be constructed to treat residual surface water and bed sediment contamination.

With the removal of floodplain and stream channel contamination in the upper reach of Silver Bow Creek, the time required to restore resources and services to baseline and to substantially recover in this reach would be virtually the same as the time required for restoration and substantial recovery under Alternative 4A.

In the other two reaches of Silver Bow Creek--in the canyon and downstream of the canyon--where no actions beyond remedy are undertaken, floodplain and stream channel contamination would remain. However, removing upstream sources of contamination that would otherwise migrate downstream will benefit aquatic resources in the downstream reaches. Leaving aside issues involving recontamination from STARS treated floodplain areas and the effectiveness of STARS in maintaining a permanent vegetative cover, the amount of remaining contamination ensures that a substantial period of time, on the order of thousands of years, would be required before the lower reaches of Silver Bow Creek return

to baseline.

Discussions of substantial recovery in this context are not particularly useful due to uncertainties associated with STARS. In the short term riparian habitat would improve relatively more than aquatic resources, which would be subject to continued contamination from surface runoff and stream channel contamination. However, to the degree riparian and aquatic resources recover, recovery may be temporary.

4.5.5 Alternative 4D

In this alternative no further action is taken at the site beyond the CERCLA response action. One-half of the Silver Bow Creek stream channel would be left in-place. A riparian zone 100 feet wide (50 feet on each bank) would be created by removal of tailings and contaminated soils and revegetating with a few grass and shrub species. In the floodplain more than 50 feet from the Creek tailings and contaminated soils would be treated with STARS and revegetated primarily with grasses. Waste piles would be constructed, treated with STARS, and revegetated primarily with grasses.

In the near-term, residual streambed, streambank, and surface water contamination would prevent benthic macroinvertebrates, fish, and other animals from reestablishing to any great degree, if at all. Riparian vegetation would mature fairly quickly and provide some bank cover, stream shading, and wildlife habitat within a decade or two. However, riparian areas would lack diversity and habitat layers and would provide limited wildlife habitat.

The consequences of floodplain erosion and stream channel migration are difficult to predict with certainty. Storm and snowmelt runoff, overbank floods, and channel migration would continue transporting floodplain materials containing hazardous substances to Silver Bow Creek. In time, any fishery that may have reestablished would likely be eliminated. The period of time over which this could happen depends largely on the loading rate of contaminants to Silver Bow Creek. This could happen gradually with small but frequent inputs from erosional processes or rather quickly during high-intensity flood events. Any widespread reversal of lime-amended soil conditions causing large areas of the floodplain to revert to its existing devegetated condition would accelerate the recontamination of Silver Bow Creek and reinjure the reestablished fishery. Thousands of years of natural processes would be required to removed hazardous substances from the Silver Bow Creek ecosystem.

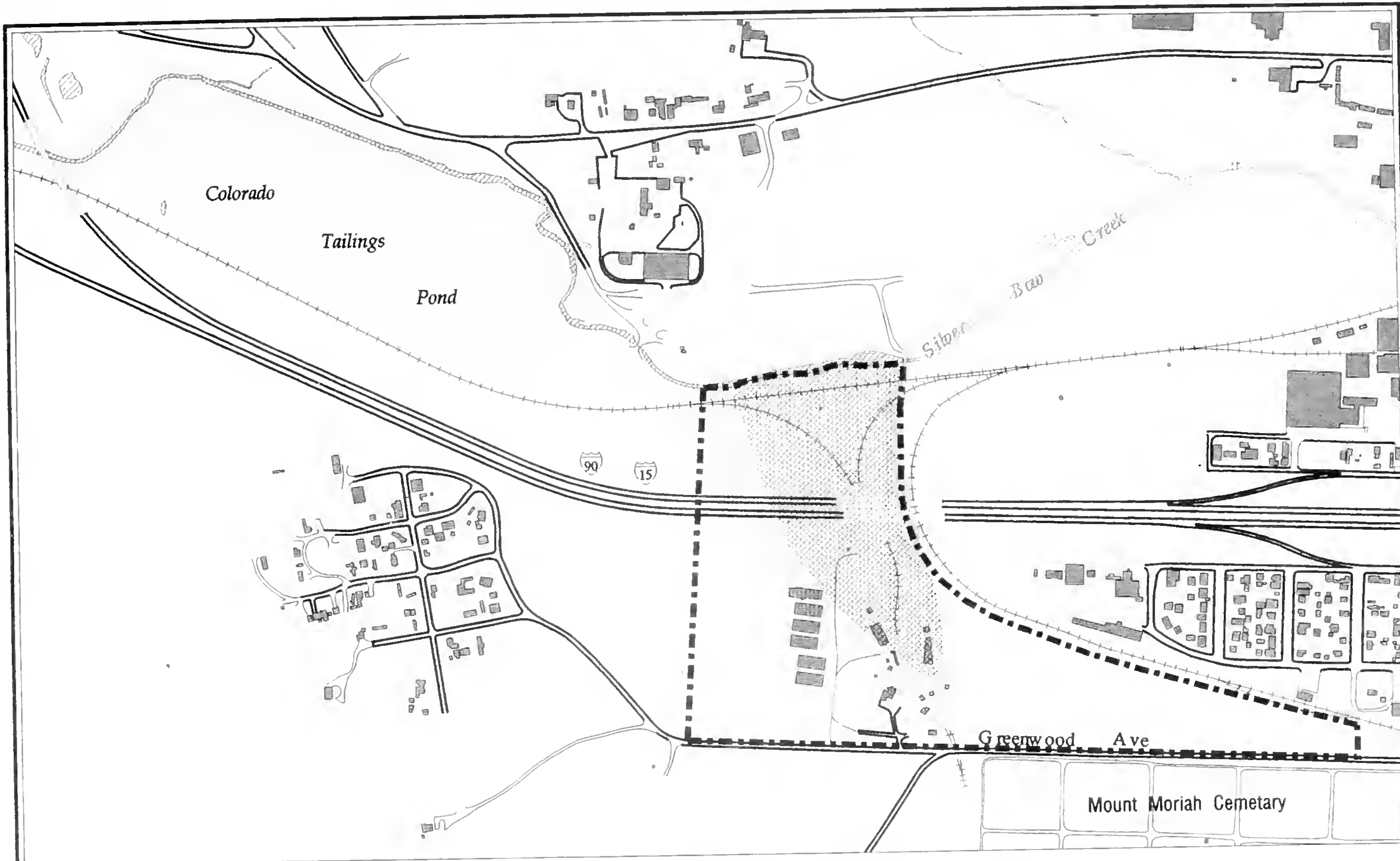
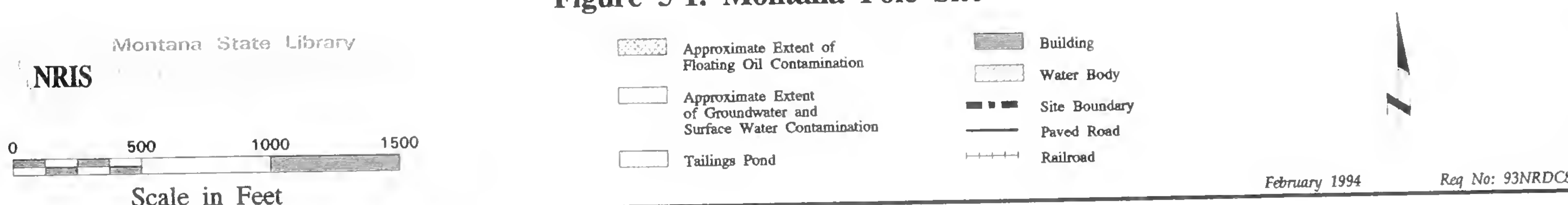


Figure 5-1. Montana Pole Site



5.0 MONTANA POLE GROUNDWATER AND SOIL RESOURCES

5.1 Description of Site and Injury

From 1946 to 1984, the Montana Pole and Treating Plant utilized pentachlorophenol (PCP) and diesel fuel to preserve wood products. The site is located in the southwest portion of Butte and is bounded on the north by Silver Bow Creek, on the east by a railroad right-of-way, on the south by Greenwood Ave, and on the west by the former location of the Colorado Smelter. An elevated portion of Interstate 15/90 cuts across the site in an east-west direction.

During the lifetime of the facility, hazardous substances--primarily in the form of PCP--were released to the environment. Other contaminants released from the plant and detected on site include: polynuclear aromatic hydrocarbons (PAH), BTEX (benzene, toluene, ethylbenzene, and total xylenes), dioxins, and furans. Due to the threat to public health and the environment from these releases, in 1987 EPA placed Montana Pole on the National Priorities List.

Wood treating fluids containing hazardous substances were released directly to the ground surface over the period of plant operations. Subsequent transport of hazardous substances through the soil and to groundwater has resulted in widespread contamination throughout the site. The connection between site groundwater and Silver Bow Creek has resulted in hazardous substances (primarily PCP) being transported to the Creek.

As measured by exceedances of the maximum contaminant level of one part per billion for PCP, the areal extent of groundwater contamination is 44 acres, with a total volume of about 350 acre-feet. Approximately 239,000 cubic yards of soil is also contaminated by PCP.

5.2 Sources of Hazardous Substances

At Montana Pole soils and groundwater contaminate each other. Specifically, the hazardous substances in the contaminated groundwater plume are in a non-aqueous phase (oil product) and a dissolved phase. The non-aqueous phase floats on top of the groundwater and is up to three feet thick. When the groundwater level fluctuates, some portion of the floating product adheres to the soils it contacts. Thus, the groundwater is continually

recontaminating soils.

Upon contact with groundwater, either through water table fluctuations or capillary action, PCP in the soils will be transported to and dissolved in the groundwater. Unlike the non-aqueous phase, the dissolved phase is not confined to the groundwater surface but extends throughout the aquifer. The dissolved phase moves with the groundwater through the aquifer to Silver Bow Creek.

Contaminated soils also serve as a source for groundwater contamination due to infiltration of precipitation. Water moving through overlying contaminated soils transport PCP and other hazardous substances to groundwater.

5.3 CERCLA Response Actions

Response actions were undertaken as early as 1985 with the installation of two groundwater interception/oil recovery systems. The following year approximately 10,000 cubic yards of contaminated soil were excavated, bagged, and placed into storage in metal buildings on-site.

Additional response actions were initiated in late 1992, and included the construction of an 890-foot barrier wall to intercept LNAPL before it reaches Silver Bow Creek and the installation of ten recovery wells. Each well has two pumps. One pump collects floating product, the other pumps groundwater to a treatment facility constructed on-site. With the installation of this system, the system installed in 1985 was shut down.

A Record of Decision (ROD), which outlines the selected remedy, was issued by MDHES and EPA in September 1993. The components of the selected remedy are outlined below:

1) excavation of 198,000 cubic yards of contaminated soils;
2) treatment of excavated soils to cleanup levels of 34 ppm for PCP by above ground biological treatment;
3) backfilling 208,000 cubic yards of treated soils meeting cleanup levels into excavated areas;
4) revegetating the site;
5) soil flushing 41,000 cubic yards of contaminated soils underlying a berm

supporting Interstate 15/90 and 3,000 cubic yards of contaminated soils underlying structures on site, such as the water treatment plant;

6) containment of contaminated groundwater and LNAPL using physical and/or hydraulic barriers (as determined during remedial design) in order to prevent the spread of contaminated groundwater and LNAPL and to limit releases of contamination to Silver Bow Creek;

7) treatment of extracted groundwater to cleanup levels by the existing treatment plant, and reinjection or discharge to Silver Bow Creek of the treated groundwater;

8) in-place biological treatment of contaminated groundwater, inaccessible contaminated soils areas, and contaminated soils not recovered by excavation; and

9) institutional controls to prevent any residential use of the site.

Under the remedy, soil excavation and treatment will address 198,000 cubic yards of soil and 10,000 cubic yards of soil stored on site. Soils will be treated until they reach the cleanup level of 34 ppm for PCP--a risk based cleanup level to protect public health for recreational and industrial uses--at which point the soils will be backfilled into the excavated area. 44,000 cubic yards of soil under the highway berm and site structures will not be excavated but will be treated by soil flushing and in-situ biological treatment.

The remedy establishes groundwater points of compliance at the waste management boundary, which will likely be the edge of the excavated area, and along the south bank of Silver Bow Creek. Pumping and treating contaminated groundwater seeks to ensure that groundwater clean-up levels are not exceeded at these points of compliance and that the plume of contamination does not migrate into uncontaminated areas or the Creek. The expectation is that over time and in response to cleanup efforts, the volumes and concentrations of contamination in the groundwater plume will be reduced to the point where natural processes will ensure that cleanup levels are maintained at the points of compliance. When the site is stabilized, albeit still contaminated, pumping and treating is to be discontinued. It is estimated this will occur in approximately 30 years.

The remedy utilizes institutional controls to prevent the use of site groundwater. Institutional controls will also address the contamination remaining in soils after treatment.

5.4 Residual Injury

The selected remedy outlined in the ROD will protect public health by reducing the volume and toxicity of the contamination presently found at the Montana Pole site and preventing further releases from the site. However, the remedy will not restore natural resources to baseline conditions, nor is it intended to.

Upon implementation of the remedy, soils and groundwater will remain contaminated above baseline conditions. Approximately 44,000 cubic yards of soil under the highway berm and site structures will be treated in-place by soil flushing and biological treatment. These treatment methods are not expected to be nearly as effective in reducing contaminant levels as excavation and above-ground treatment are expected to be. It is estimated that these soils constitute approximately 10% of the existing contamination. Considering the extent and degree of contamination at the site, substantial residual contamination will remain. By the processes described earlier, contaminants in these soils will be transported to groundwater.

Soils that are excavated, treated to 34 ppm, and backfilled will also remain contaminated. Because the excavation will extend below the water table and because the water table fluctuates, contaminants in the backfilled, treated soils will be transported from soils to groundwater. Contaminants in backfilled soil above the water table will also be transported to groundwater as precipitation infiltrates through the soil.

Although the remedy's pumping and treating and in-situ biological treatment program will reduce levels of contamination, it will not (and does not attempt to) restore groundwater to baseline conditions. Rather, the program reduces contamination and limits the spread of the plume. Once the plume is contained within the site, pumping and treating will cease and residual contamination is to be addressed by natural processes. It is estimated that 350 acre-feet of groundwater will remain contaminated upon completion of the remedy.

5.5 Restoration Alternatives

5.5.1 Introduction

As discussed in Section 1.2.2., restoration planning will be coordinated, to the maximum possible extent, with response action planning. The Natural Resource Damage Program (NRDP) will endeavor to implement restoration actions in conjunction with the response action. Such coordination seeks to ensure that restoration actions do not conflict with the chosen response action.

In the preceding sections, NRDP notes that while remedy reduces and contains contamination, the remedy will leave contamination on-site in the form of soils under the highway berm and other site structures and backfilled soils at the 34 ppm cleanup level for PCP. To address these sources of contamination, alternatives are proposed that would result in the undoing of the remedy if the remedy is implemented prior to the restoration action. As noted, it is NRDP's intention that conflicts be avoided by coordinating with CERCLA response authorities. Accordingly, the alternatives are premised on the assumption that the remedy and the restoration action are implemented simultaneously and that the remedy will not be undone. However, even if a conflict were to exist between remedy and restoration, the alternatives would be worthy of consideration.

5.5.2 Alternative 5A

This alternative seeks to restore resources and services to baseline in as short a time as possible. It does this by removing all accessible sources of contamination and by continuing pumping and treating to remove all contaminants and address residual on-site contamination. Its critical elements include:

1) excavation of contaminated soils under the highway berm;
2) off-site disposal of soils to be treated and soils excavated under the highway berm;
3) backfilling excavated areas with clean fill and highway berm replacement;
4) pumping and treating contaminated groundwater with in-place biological treatment; and
5) natural recovery.

Under this alternative, 208,000 cubic yards of contaminated soils to be treated and backfilled under remedy would, instead, be disposed of off-site. 41,000 cubic yards of contaminated soils beneath the highway berm would be excavated. This would require the removal of two highway support structures and the portion of the highway on top of the berm. It would also require the excavation and stockpiling of the berm to access the contaminated soils. This task would take approximately 2 months. Disposal of contaminated soils would occur off-site.

Pumping and treating would be necessary to address on-site contaminated groundwater remaining after the remedy. Groundwater would be pumped using the wells and/or recovery trenches employed during remedy. Groundwater would be treated to remove contaminants and then oxygenated prior to reinjection into the aquifer. The oxygenated water will enhance natural biological activity and help break down the organic compounds (PCP) in the soil and the groundwater. Pumping and treating would continue until site groundwater complies with drinking water standards, i.e., there are no detectable levels of PCP.

Under this alternative restoration of resources and services to baseline would occur in approximately 30 years. This is the time it will take to return groundwater to drinking water standards for PCP.

Due to the fact that virtually all sources of contamination are being addressed under this alternative, significant benefits would accrue to the resource relatively rapidly. Substantial recovery would occur within 10 years.

5.5.3 Alternative 5B

This alternative removes a significant source of contamination at the site and relies, in large part, on the remedy's components. Its critical elements include:

1) excavation of contaminated soils under the highway berm;
2) land-treatment of soils excavated from under the highway berm and relocating the soils to the site-wide excavation;
3) backfilling excavated area with clean fill and highway berm replacement;
4) pumping and treating contaminated groundwater with in-place biological treatment; and

5) natural recovery.

By removing 41,000 cubic yards of contaminated soils under the highway, this alternative addresses a major source of contamination remaining on site after implementation of the remedy. Contaminated soils from underneath the highway berm would be land-treated to the PCP cleanup level of 34 PCP and placed into the site-wide excavation along with the other 208,000 cubic yards. Contaminated soils from underneath the berm would not be put back into their original location because the berm and the highway have to be reconstructed immediately and cannot wait for a reduction in soil contaminant levels.

As in Alternative 5A, pumping and treating would be necessary to address contaminated groundwater remaining on-site after remedy.

Under this alternative, more contamination is being left on-site than in Alternative 5A. Contamination located in the backfilled, treated soil will migrate to groundwater. Pumping and treating and biological treatment would partially address this contamination. Residual contamination will also be depleted as a result of biological and chemical processes. It is estimated that restoration of resources and services to baseline would occur in about 60 years. Substantial recovery would take disproportionately longer under this alternative than under Alternative 5A when compared to the length of time for restoration to baseline because with less source removal the resource will improve at a slower rate. It is estimated that substantial recovery would occur in approximately 30 years.

5.5.4 Alternative 5C

This alternative relies on pumping and treating, rather than removal. Its critical features include:

1) pumping and treating contaminated groundwater with in-place biological treatment; and
2) natural recovery.

Under this alternative, residual soil contamination would be addressed indirectly by allowing contaminants to migrate to groundwater and then by treating the groundwater. With no removal of contaminated soils, this alternative ensures a longer period for restoration. It is estimated that restoration of resources and services to baseline would take approximately

100 years. Substantial recovery would occur in approximately 60 years.

5.5.5 Alternative 5D

In this alternative no further action is taken at the site beyond the remedy. Monitoring and oversight would occur to evaluate site conditions and the process of natural recovery. As described earlier, pumping and treating would cease pursuant to the remedy when the site was stabilized, which is estimated to occur in 30 years. Natural recovery would then be relied on to restore the site to baseline. As a result of ceasing pumping and treating, it will take considerably longer to reach baseline in this alternative than under the previous alternatives. It is estimated that restoration of resources and services to baseline would occur in a few centuries. Substantial recovery will occur in approximately 100 years.

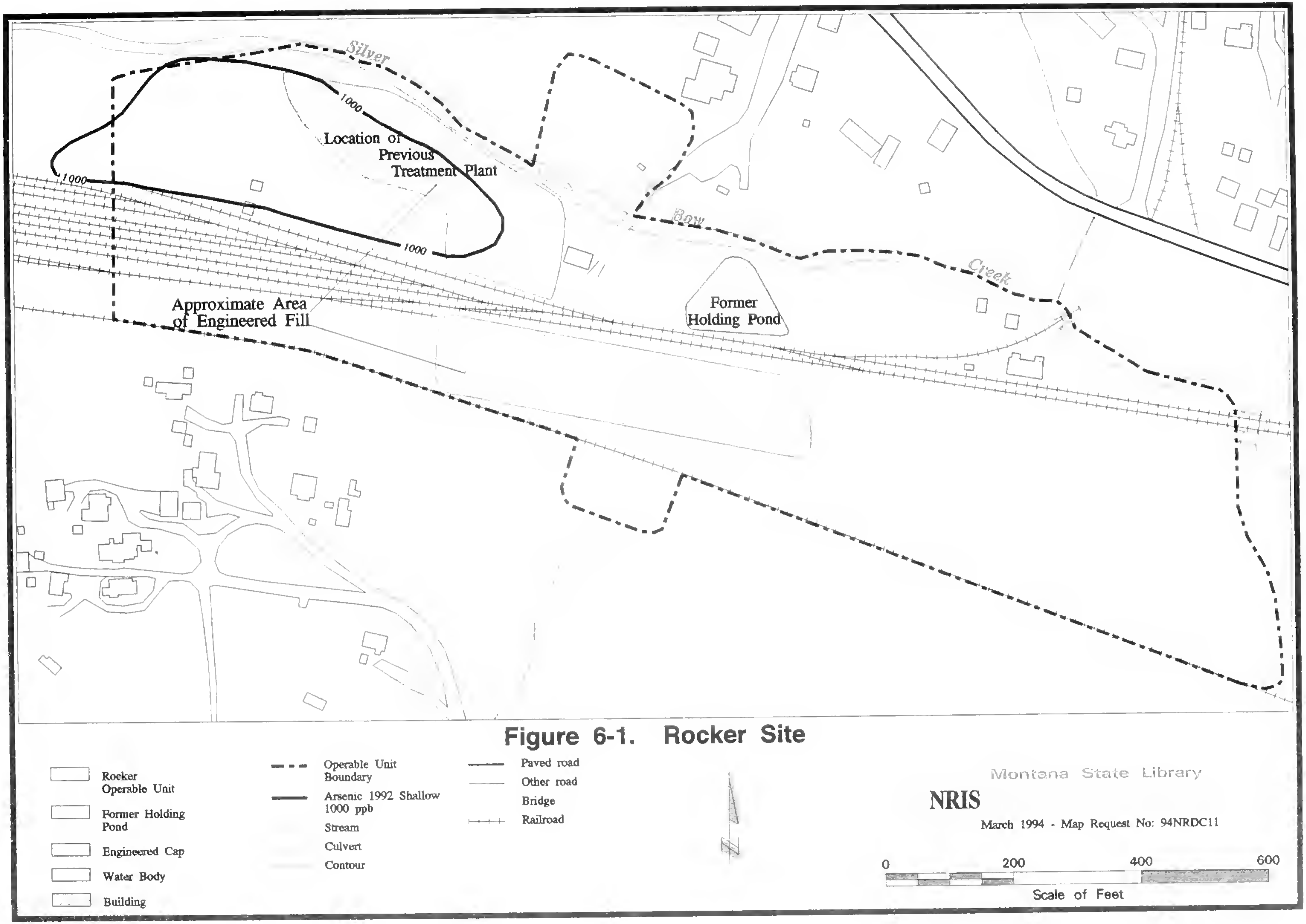


Figure 6-1. Rocker Site

6.0 ROCKER GROUNDWATER AND SOIL RESOURCES

6.1 Description of Site and Injury

The site of the former Rocker Timber and Framing Plant is adjacent to Silver Bow Creek approximately 7 miles west of Butte. The plant milled and treated timbers for the mining industry utilizing a process that required the application of dissolved arsenic and creosote. Releases of hazardous substances have resulted in soil and groundwater contamination. The site is a unit of the Silver Bow Creek/Butte Addition NPL site.

Organic compounds, metals, and metalloids released from wood treatment processes have been transported through soils to the water table and have contaminated the groundwater system underlying and adjacent to the site. Contaminants include arsenic, cadmium, copper, lead, zinc, iron, manganese, sulfate, and polynuclear aromatic hydrocarbons (PAH).

As delineated by exceedances of drinking water standards for various contaminants, there are approximately 202 acre-feet of contaminated groundwater. The areal extent of the contamination is about 20 acres. Arsenic, which is the contaminant of most concern at Rocker, is present in concentrations above drinking water standards in approximately 83 acre feet of groundwater. The arsenic plume is approximately 10 acres in areal extent.

The plumes of contamination extend to the west and below Silver Bow Creek and in a few areas extend below the land surface approximately 50 feet. However, contamination is more severe in the shallow portions of the groundwater system. Contaminated groundwater may discharge to Silver Bow Creek.

Significant soil contamination exists at Rocker. Although contamination is present throughout the site, it is most severe in the northern part of the site where most of the plant's operations were conducted.

6.2 Sources of Hazardous Substances

At Rocker soils and groundwater contaminate each other. Contaminants in groundwater adhere to aquifer materials. In turn, contaminated soils are a source of contamination to groundwater. Infiltrating precipitation leaches contaminants from soil to groundwater. Contaminants attached to soil surfaces that are in contact with groundwater

can disassociate from the soil and migrate to groundwater under changing geochemical conditions. Accordingly, soil contamination perpetuates the contamination of groundwater and the migration of hazardous substances at the site.

In the northern part of the site at the location of the former treatment plant, the areal extent of soil contamination from releases of hazardous substances directly onto the land surface is approximately two acres. Based on an area-wide average eight foot depth to the water table, the volume of severely contaminated soils overlying the water table is approximately 25,800 cubic yards.

Underlying the contaminated soils discussed above are additional contaminated soils at and below the water table. While soil contamination may extend 25 feet below the water table, those soils from the water table to four feet below the water table contain concentrations of hazardous substances significantly higher than soils below this level, and thus constitute a more significant source of contamination to groundwater. The volume of these soils is approximately 12,900 cubic yards.

Additional contaminated soils and aquifer materials of concern are those associated with the groundwater arsenic plume. The soils of greatest concern are those within the groundwater 1,000 ppb arsenic isopleth, which extends over approximately three acres and represents the most highly contaminated groundwater at the site. Soils associated with this plume are likely to be highly contaminated. Approximately one-acre of this three-acre area is within the area described above. Not including any soils previously accounted for, the volume of contaminated soils within the 1,000 ppb arsenic isopleth and from four feet below the water table to two feet above the water table is 19,360 cubic yards.

6.3 CERCLA Response Actions

In 1989, in order to address an immediate threat posed by materials with arsenic concentrations greater than 10,000 parts per million (ppm), approximately 1,021 cubic yards of arsenic-contaminated soil and wood chips were removed from the site. After removal of the materials, 12 inches of clean fill (8,800 cubic yards) were placed over a four-acre area.

Based on a review of the RI/FS literature, an evaluation of actions implemented or planned at other sites in the Basin, consideration of ARCO's position, and discussions with EPA and MDHES personnel, the Natural Resource Damage Program identifies the following

actions as likely to be implemented at Rocker:

1) excavation of soils with arsenic concentrations of 1,000 ppm or above;
2) backfilling excavated areas with clean fill; and
3) institutional controls to prohibit the construction of wells in or near the area of contamination.

The cleanup standard for soils, 1,000 ppm, seeks to ensure that recreational visitors to the site are not subject to an unacceptable health risk. Soils above this level are scattered throughout the site but are found primarily in the two-acre treatment plant area. It is estimated that there are 6,000 cubic yards of soils exceeding the cleanup level. Disposal and/or treatment will occur off-site.

6.4 <u>Residual Injury</u>

The estimated remedy will not restore resources to baseline conditions, nor is it intended to. As mentioned above, the remedy is based on an acceptable level of risk for those individuals who recreate on the site. Consequently, significant residual injury will remain.

Specifically, soils will contain concentrations of hazardous substances well above baseline conditions. Although the most contaminated soils will be removed under remedy, the vast majority of contaminated soils presently found on site will remain on site after implementation of the remedy. As discussed, the residual level of contamination will limit uses of the site for the foreseeable future.

Since soil contamination results in groundwater contamination, residual injury to soil causes residual injury to groundwater. After implementation of the remedy, there will be approximately the same amount of contaminated groundwater as there is presently.

6.5 <u>Restoration Alternatives</u>

6.5.1 <u>Introduction</u>

Contamination is extensive at Rocker. While hazardous substance concentrations are, in general, highest in near-surface soils and in shallow portions of the aquifer, a significant amount of contamination is located at depth. Even if these deeper sources of contamination were not removed and were only addressed indirectly by pumping and treating, source

removal of near-surface and shallow-zone contamination would produce significant benefits to the resource. The following alternatives focus on removal of these shallower sources. Groundwater pumping and treating will address residual contamination. Because site contamination involves metals, arsenic, and organics different pumping and treating systems will need to individually address each of these types of contamination.

6.5.2 Alternative 6A

In this alternative contaminated near-surface and shallow-zone soils would be removed. The key elements of this alternative are:

1) removing contaminated soils in the treatment plant area associated with releases of hazardous substances to the land surface;
2) removing contaminated soils associated with the area of most severe groundwater contamination;
3) disposing of excavated soils off site;
4) backfilling excavated areas and revegetating;
5) pumping and treating; and
6) natural recovery.

Soils that would be removed include all soils in the treatment plant area to a depth of twelve feet. Assuming that the 6,000 cubic yards to be removed under remedy is from this area, a total of 32,720 cubic yards would be removed.

In addition, soils contaminated by groundwater, beginning at a depth of six feet and extending to a depth of 12 feet, within the 1,000 ppb arsenic isopleth would be removed. The volume of soils to be removed is 19,360 cubic yards. Uncontaminated soils overlying this layer would be stockpiled for backfilling.

Subsequent to soil removal, groundwater contamination would be addressed by pumping and treating. Treatment of metals, arsenic, and organics would occur in sequence. Twenty wells would be installed at 100 foot intervals overlying the 1,000 ppb contour of the arsenic plume.

In this alternative, sources of severe contamination are removed. Pumping and treating, in conjunction with natural recovery, would address residual levels of groundwater contamination. Restoration of resources and services to baseline would occur in

approximately 100 years. Substantial recovery, whereby a portion of the site presently exceeding drinking water standards would meet these standards, is estimated to occur in approximately 40 years.

6.5.3 Alternative 6B

In this alternative only those severely contaminated soils in the treatment plant area to a depth of 12 feet would be removed. The key elements of this alternative are:

1) removing contaminated soils in the treatment plant area associated with surface releases;
2) disposing of excavated soils off site;
3) backfilling excavated areas and revegetating;
4) pumping and treating; and
5) natural recovery.

Under this alternative, 32,720 cubic yards of contaminated soils would be removed, assuming that the 6,000 cubic yards to be removed under remedy are in this area. Unlike Alternative 6A, contaminated soils from four feet below to two feet above the water table within the 1,000 ppb arsenic isopleth would not be removed. Pumping and treating will address residual contamination as hazardous substances mobilize from soils to groundwater.

Since more source material is being left in-place under this alterative than Alternative 6A, restoration time will be lengthened. It is estimated that restoration of resources and services to baseline would occur in approximately 200 years. Substantial recovery would occur in approximately 100 years.

6.5.4 Alternative 6C

In this alternative no further action is taken at the site beyond the CERCLA response action. Monitoring and oversight would occur to evaluate site conditions and the process of natural recovery. It is estimated that restoration of resources and services and substantial recovery would occur in several centuries.

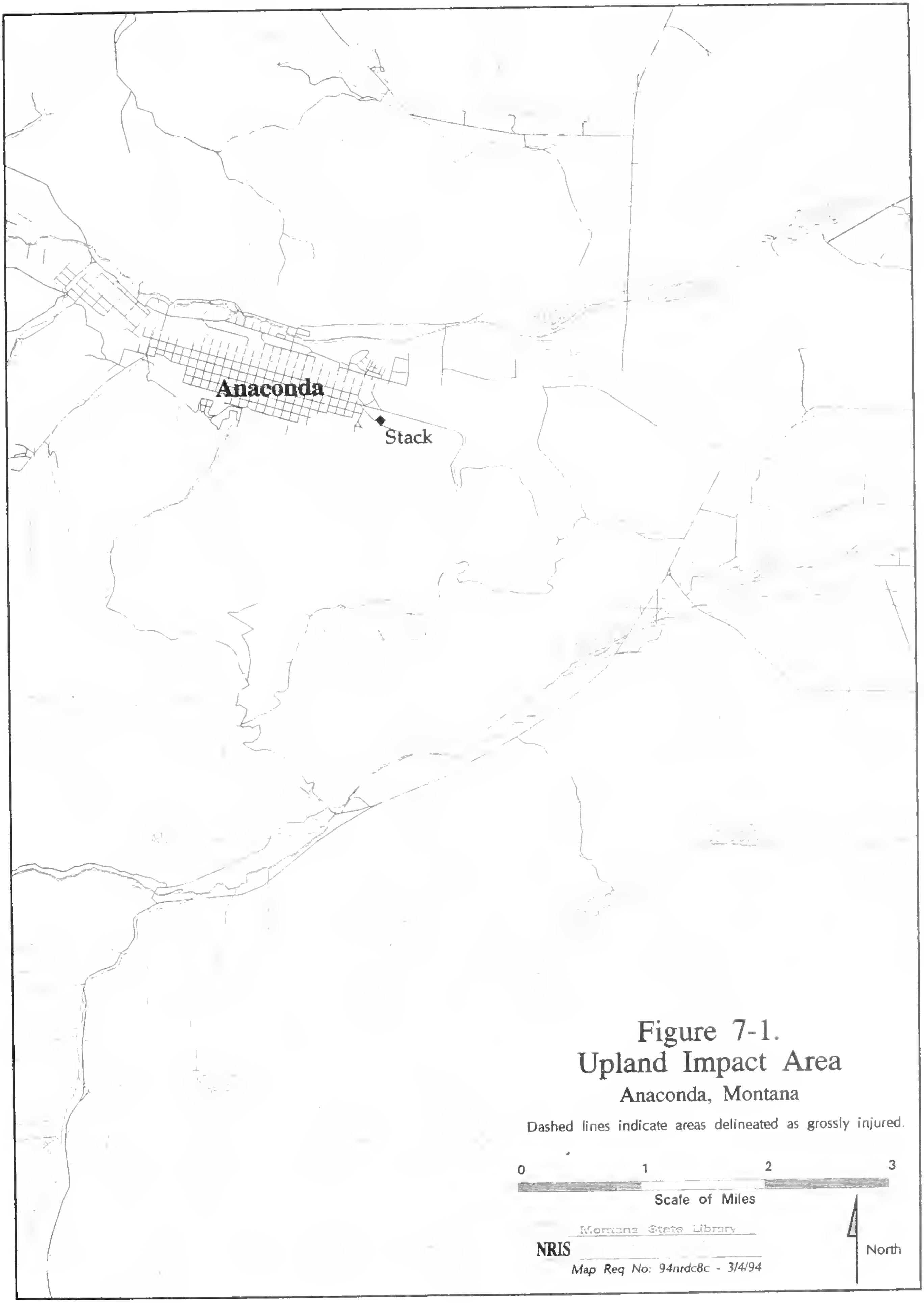


Figure 7-1.
Upland Impact Area
Anaconda, Montana

Dashed lines indicate areas delineated as grossly injured.

7.0 SMELTER HILL AREA UPLAND RESOURCES

7.1 Description of Site and Injury

The Smelter Hill area upland habitat resource includes areas on Smelter Hill, Stucky Ridge, and Mount Haggin. The region has been injured due to releases of hazardous substances from mineral-processing activities. Enormous volumes of hazardous substances were continually released into the air by these operations and subsequently deposited onto the land.

The primary source of hazardous substances to upland resources were emissions from the Washoe (or Anaconda) smelter. Emissions from the Washoe smelter stack resulted in the deposition of hazardous substances across hundreds of square miles of surface soils surrounding and downwind from the town of Anaconda. This has resulted in injury to soils, vegetation, wildlife habitat, and wildlife.

The injury determination for upland resources delineated those areas displaying gross (visible) injury attributable to the deposition of hazardous substances that were released as primary smelter emissions and/or secondary fugitive dust emissions. Grossly injured resource areas are defined as those areas which exhibit the following:

1) Complete or virtual elimination of indigenous major plant associations.
2) Little or no regeneration of indigenous major plant associations.
3) Extensive topsoil exposure and erosion due to vegetation loss.

Upland areas which meet the grossly injured criteria extend across approximately 17.7 square miles (11,366 acres) of land. The grossly injured area encompasses the eastern portion of Stucky Ridge and the hills on the north side of Lost Creek (2,409 acres), areas to the west and south of Smelter Hill (4,653 acres), and portions of Mount Haggin east of the Mill Creek Highway (4,304 acres). Elevations in the grossly injured area range from 5,300 feet at Lost Creek to over 7,000 feet on Mount Haggin. Out of the 11,366 acres that are grossly injured, 2,200 acres, or approximately 20% of the total, are located on slopes greater than 40 degrees. Extensive topsoil loss is associated with much of this area. Other areas displaying topsoil loss include a cobbled area on Stucky Ridge.

Soils in the grossly injured area have elevated concentrations of hazardous substances

including arsenic, cadmium, copper, lead, and zinc. Laboratory tests have confirmed that these soils are phytotoxic, which is consistent with visual observation. Metal concentrations are highest in the upper two inches of soil. Elevated metal concentrations on the soil surface prevent seed germination, which explains the lack of natural recovery in the area. Absent human intervention, concentrations will not be reduced sufficiently to allow for revegetation in a reasonable time frame.

In the injured area there has been a shift in plant community types from predominantly forests with open grassland to predominantly sparse grassland or bare ground. Absent hazardous substances in the soil, Smelter Hill and Mount Haggin would have vegetative cover consisting of approximately 70% forest and approximately 30% grassland; Stucky Ridge would have vegetative cover consisting of 30% forest and 70% grassland. Of the total 11,366 acres that exhibit gross injury and are essentially devegetated, 6,993 acres (62%) would have been primarily forest land and 4,373 acres (38%) would have been primarily grassland.

The elimination of upland vegetation communities in the grossly injured area has resulted in a severe reduction in the quantity and quality of wildlife habitat. Wildlife such as birds of prey, woodpeckers, songbirds, squirrels, porcupine, and marten have suffered local extinction in the impacted areas. Other species, including black bear and elk, are likely to have suffered population reductions.

7.2 Sources of Hazardous Substances

As noted above, the primary source of hazardous substances released to upland resources were emissions from the Washoe smelter stack. Mining and mineral-processing wastes disposed of directly on land surfaces in the Anaconda area are also sources of hazardous substances. Aerial deposition has resulted in widespread soil contamination. These contaminated soils are sources of on-going releases of hazardous substances through transport by the wind and redeposition onto the land surface and through surface runoff into water resources.

7.3 CERCLA Response Actions

Based on a review of the RI/FS literature, an evaluation of actions implemented or planned at other sites in the Basin, consideration of ARCO's position, and discussions with EPA and MDHES personnel, NRDP estimates that remedial actions in the grossly injured area will entail grass and shrub reestablishment and berm construction for erosion control across 200-400 acres of Smelter Hill. Remedial actions will focus on the location of the former smelter complex. Metal contamination can extend to depths of 4 feet in this area. Accordingly, extensive land disturbance will be required in order to reestablish vegetation.

7.4 Residual Injury

The residual injury to upland resources will essentially equal the current condition of the resource. Hazardous substance concentrations will remain elevated in surface soils resulting in continuing phytotoxicity. Thus, upland soils, vegetation, wildlife habitat, and wildlife will remain injured in the 17.7 square miles around Smelter Hill.

7.5 Restoration Alternatives

7.5.1 Introduction

Excluding an alternative that relies entirely on natural recovery, three restoration alternatives have been developed to address the residual injuries to upland resources in the Smelter Hill, Stucky Ridge, and Mount Haggin areas. No alternative proposes to take actions across the entire grossly injured area. Approximately 20% of the entire area is so severely injured and/or would be so difficult to revegetate that, at present, it does not appear appropriate to display an alternative that would revegetate this area.

All the alternatives focus, to a greater or lesser extent, on restoring the grossly injured area to the forest, shrub, and grassland communities that would have existed if releases of hazardous substances had not occurred. Comparisons to baseline conditions indicate that after remedy the grossly injured area should consist of approximately 6,799 acres (62%) of forest land and 4,167 acres (38%) of grassland. Restoration alternatives will reflect this forest/grassland proportion. The spatial distribution of these communities and the characteristics of the communities, i.e., species to be revegetated, will depend on site conditions, such as slope, aspect, elevation, and surface soil condition.

Density of tree and shrub plantings will vary throughout the area in order to accommodate a diversity of species for wildlife habitats. For example, small areas of approximately 3 hectares of dense fir growth can be established in association with extensive meadow or shrubland habitat to provide forage, escape, and thermal cover for ungulates. Small openings, planted with grasses and forbs, along with an interspersion of open-moderate and closed-canopy cover with understory thickets of willow, alder, and ground juniper will create additional wildlife habitat.

Revegetation of the injured area will provide cover and reestablish the vegetation complexity necessary to support viable populations of wildlife species typical of Montana upland habitat in this area. Each of the three alternatives will, to a greater or lesser extent, create improved conditions for wildlife within a reasonable period of time.

Tree planting density will require approximately 450 native trees or shrubs per acre. Tree mix will include Douglas Fir, Lodgepole Pine, Subalpine fir, Limber Pine and Juniper. Seeds for nursery stock growth will be gathered from nearby trees at the same altitude. As discussed above, selection of tree species to be planted will be based upon those species best adapted to thrive on specific sites. For example, Limber Pine and Juniper are best adapted to dry, low elevation areas on west and south aspects while fir and Lodgepole Pine are best suited to moist, high elevation areas.

Shrub species that provide forage and/or escape cover include willows, alders, red-osier dogwood, chokecherry, buffalo-berry, low-bush cranberry and silverberry. Several of these have the added advantage of being berry producers or nitrogen fixers (e.g., silverberry, alders). Forbs such as Lupine species will also be planted in order to provide forage. Seeds for both forbs and shrubs will be collected from nearby areas.

Revegetative success depends on the active mixing or turning of the contaminated land surface to expose uncontaminated soils and reduce metal concentrations. Revegetative success will also depend on accomplishing land disturbance and revegetation over a large enough area to establish a vegetative community capable of moderating the microclimate and providing organic matter and seeds to the surrounding area.

In areas that are designated primarily for tree establishment, the surface will be altered by the creation of terraces approximately 200 feet apart. The microclimate

established in the depression of the terrace will be characterized by lower velocity winds, greater moisture retention, and reduced potential for wind and water erosion. The lip of the terraces will also have lower levels of contamination and improved microsites for seed germination. The terrace and lip area will provide an approximately 50 foot wide zone that will serve as critical habitat core areas. Grasses and shrubs will also be planted or seeded in these terraces. Constructing terraces over a given area will disturb approximately 25% of the contaminated surface.

The land surface between the terraces will remain contaminated and barren of vegetation absent surface disturbance. Thus, hand tools will be used to plant individual trees and shrubs in the inter-terrace area. This activity will alter the soil surface in the immediate vicinity of the plant, allowing for seed recruitment. In addition, small (square meter) basins will be hand dug and hand seeded with native grasses in areas between plantings. Although actions in the inter-terrace area will not substantially increase the total amount of land surface disturbed and revegetated over that accomplished by the terraces, the actions will be valuable in allowing vegetation to establish a foothold in the inter-terrace area.

For grassland reestablishment areas, basins will be created with a specialized tractor that will scrape away the acidic, metals-rich surface soil and create gouges that allow for moisture retention rather than runoff. Soils that are turned over and lap out of the gouges will also have reduced surface contamination and will expand the area available for planting. Basin construction over a given area will disturb more than one-half of the land surface. Where appropriate, berms will be placed at 500 foot intervals for erosion control.

Native species of grass such as wheatgrass, fescues, and blue grass will be seeded in and around the basins. In order to assist grass propagation, fertilizer and manure will be applied to the soil.

7.5.2 Alternative 7A

In this alternative, a significant percentage of the grossly injured area will be revegetated. The critical elements of this alternative are:

1) revegetation over 60% (6,580 acres) of the grossly injured area during years 1-10;
2) maintain planting levels by replacing dead trees, shrubs, and grasses during

years 2-11;

3) revegetation over 20% (2,193 acres) of the grossly injured area during years 11-15; and

4) natural recovery.

Under this alternative revegetation efforts are directed first at those areas with relatively favorable conditions for revegetative success constituting 60% of the grossly injured area. Twenty percent of the grossly injured area would be revegetated after actions are completed on the relatively easier area. Revegetation efforts would be phased. Revegetation of the 60% area would occur in years 1-10; revegetation of the 20% area would occur in years 11-15. Plantings in the first ten years would be maintained to ensure survival.

As discussed earlier, areas between plantings would retain elevated surface concentrations of hazardous substances. In these areas virtually no seed germination would occur. Seeds that manage to germinate would be unlikely to survive. In addition, it is likely that revegetative success over the 20% area would be spotty. In the end, natural processes must be relied on to address remaining contamination and injury.

Over time, the revegetated areas would encroach upon the undisturbed, devegetated areas. A layer of humus should develop as reestablished vegetation sheds organic matter. Invertebrates, which have gradually returned to the core areas, will be recruited to the undisturbed, devegetated areas when metal concentrations are reduced and sufficient organic matter is available. Invertebrates will mix the organic litter with soil from the surface containing elevated levels of metals and with soil from below. This would further reduce metal levels. When surface soil metals concentrations are significantly reduced from present levels, seed germination can occur.

Because of the magnitude of the injury this process will be extremely slow. Restoration of resources and services to baseline conditions will occur in hundreds or even thousands of years.

Notwithstanding the foregoing discussion, in areas where the surface has been disturbed significant benefits to the resource can be realized. With the growth of trees, shrubs, and grasslands, the reestablishment of habitat complexity, and the availability of cover and a forage base, portions of the grossly injured area would again be able to support

wildlife. Given the present condition of the upland resource, the establishment of a vegetative community representative of baseline conditions over any part of the grossly injured area would constitute an improvement on the scale of many orders of magnitude. Notable improvements would occur in a short period of time--a decade or two--as vegetation takes hold. Substantial recovery would be maximized in approximately 50 years--the length of time for vegetation to reach relative maturity. After the reestablished vegetation reaches maturity, the rate of improvement in the condition of the uplands would slow greatly as restoration becomes a function of natural processes.

7.5.3 Alternative 7B

In this alternative revegetation efforts would occur over 60% of the grossly injured area. The critical elements of this alternative are:

1) revegetation over 60% (6,580 acres) of the grossly injured area during years 1-10;
2) maintain planting levels by replacing dead trees, shrubs, and grasses during years 2-11; and
3) natural recovery.

Due to the fact that revegetation would extend across approximately 2,200 fewer acres under this alternative as compared to Alternative 7A, restoration of resources and services to baseline conditions would take longer under this alternative than Alternative 7A. However, given the time frames involved, the difference between the two alternatives would probably not be significant.

The time frame for substantial recovery would also be similar under this alternative as under Alternative 7A. For both alternatives the determining factor would be the rate of vegetation growth, and this should be basically the same for both alternatives. The difference between the alternatives is the extent of recovery once it occurs. In this alternative, 2,193 acres would lack the forest land and grassland communities established under Alternative 7A. These acres would have to rely entirely on encroachment by the revegetated areas and natural processes for recovery.

7.5.4 Alternative 7C

In this alternative revegetation efforts would occur over 30% of the grossly injured area. The critical elements of this alternative are:

1) revegetation over 30% (3,290 acres) of the grossly injured area during years 1-10;
2) maintain planting levels by replacing dead trees, shrubs, and grasses during years 2-11; and
3) natural recovery.

Vegetation reestablishment under this alternative would provide habitat islands. The islands would be designed to take advantage of site conditions. Integrating the islands into the landscape would optimize the amount and spatial distribution of vegetation types. The islands would provide wildlife habitat and serve as corridors to other islands and areas with existing vegetation.

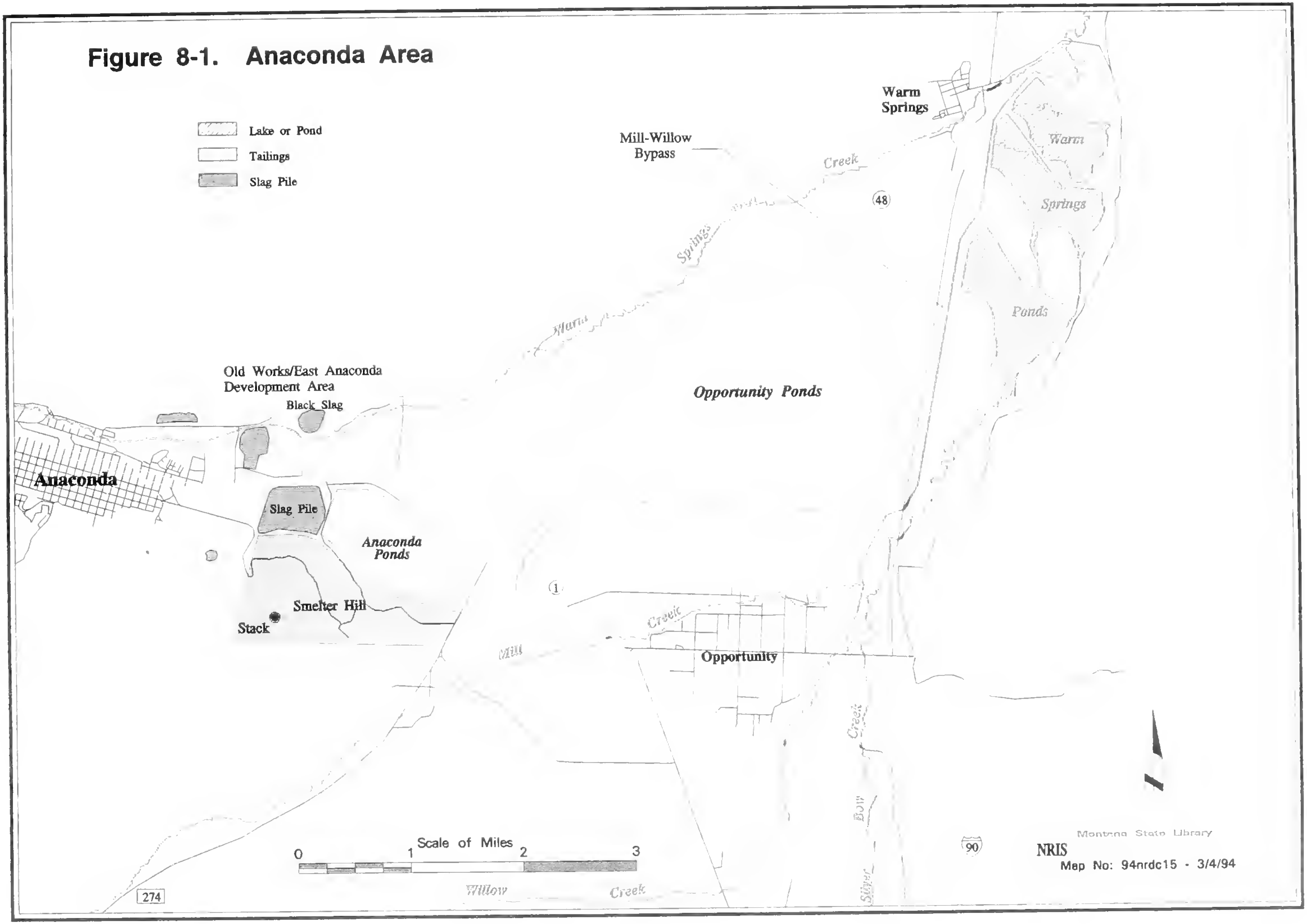
In this alternative the much reduced extent of the grossly injured area subject to revegetation as compared to Alternatives 7A and 7B will lengthen, possibly significantly, the time for restoration of resources and services to baseline over the other alternatives.

Within the revegetated areas, substantial recovery would occur in roughly the same time frame as occurred in the other two alternatives. Again, the distinguishing feature of this alternative when compared to the other alternatives is the extent of recovery once it occurs. Under this alternative, 70% of the grossly injured area, or 7,676 acres, would depend on recovery from encroachment and natural processes.

7.5.5 Alternative 7D

In this alternative nothing further is done to the grossly injured area. In this event, surface soils will remain contaminated for the foreseeable future, preventing seed germination and revegetation. Due to the persistent nature of hazardous substances, restoration of resources and services to baseline will be on the order of thousands of years if it occurs at all. Substantial recovery will take somewhat less time, but given the time frames involved the difference between the two measures is not significant.

Figure 8-1. Anaconda Area



8.0 ANACONDA AREA RESOURCES

8.1 Description of Site and Injury

Disposal, releases, and spills of solid mining wastes, milling debris, smelting by-products, and process fluids occurred over the last 110 years in the Anaconda area. Mining and processing wastes containing hazardous substances have caused injury to the area's groundwater and riparian resources. This chapter addresses five discrete areas of groundwater contamination: Old Works, Smelter Hill, Anaconda Ponds, Opportunity Ponds, and Warm Springs Ponds.

Copper ore mined in Butte was processed at Old Works along Warm Springs Creek from 1883 to shortly after the turn of the century. During this period, tailings and slags were deposited at and around the facility. These wastes contain high concentrations of arsenic, cadmium, copper, lead, and zinc. Waste disposal has injured the alluvial groundwater system around Old Works.

In 1902, the Washoe Works (Anaconda Smelter) began operations on Smelter Hill, expanding Anaconda copper production exponentially. By the 1930s, thousands of tons of ore were processed on a daily basis, producing up to one million pounds of copper per day. Infrastructure to support the smelting operations included buildings, waste piles and lagoons, leaching pads, rail lines, and all manner of industrial facilities extending across approximately 600 acres of Smelter Hill. In the course of operations, large volumes of hazardous substances were released into the environment. Both historical and current releases of hazardous substances have injured the bedrock aquifer of Smelter Hill with arsenic, cadmium, iron, manganese, zinc, fluoride, sulfate, and total dissolved solids (TDS) at concentrations exceeding drinking water standards. From Smelter Hill groundwater flows to the east and north to the valley alluvial aquifer and then to the east-northeast towards Opportunity Ponds, eventually discharging to Mill-Willow Bypass, Warm Springs Creek, and the Clark Fork River.

Tailings from the Washoe operation were deposited in the 560-acre Anaconda Ponds and the 3400-acre Opportunity Ponds. The Anaconda Ponds were constructed in 1902. Use of these ponds ceased in 1910 with the construction of Opportunity Ponds. In the mid-1940s,

tailings disposal resumed at an expanded Anaconda Ponds. During smelter operations, over 3.8 million gallons per day of wastewater and tailings slurry was discharged to Anaconda Ponds and over 30 million gallons per day of wastewater and tailings slurry was discharged to Opportunity Ponds. In the early 1960s, with the opening of the Weed Concentrator at Butte and tailings disposal at Yankee Doodle Tailings Pond above Berkeley Pit, use of Anaconda and Opportunity Ponds was diminished. All disposal at the Ponds ceased in 1980 when the Smelter closed.

Tailings disposal has resulted in significant groundwater contamination. For example, groundwater from wells constructed just down-gradient of Opportunity Ponds has elevated concentrations of contaminants at depths to at least 70 feet below the water table. At the present time, plumes of contamination of arsenic, cadmium, and zinc are smaller than plumes of iron, manganese, sulfate, and TDS. The former set of plumes are found beneath the Ponds only, while the latter set of plumes are found beneath and downgradient of the Ponds.

Prior to 1920, Silver Bow Creek was dammed to create the first two Warm Springs Ponds; the third Pond was built in the mid-1950s. Combined the Ponds cover an area of approximately four square miles. The Ponds settle mining and smelting wastes that migrate downstream from the Butte area. Seepage from Warm Springs Ponds has injured groundwater to at least 40 feet below the water table as evidenced by exceedances of drinking water standards for arsenic, cadmium, fluoride, iron, manganese, and sulfate.

The total volume of injured groundwater in the Anaconda area is estimated to be 327,400 acre-feet extending over 25 square miles. Specifically, alluvial and bedrock groundwater exceeds drinking water standards for arsenic, cadmium, chromium, iron, manganese, mercury, sulfate, zinc, fluoride, and TDS.

In addition to the groundwater injury, the tailings at Opportunity Ponds are phytotoxic. The absence of vegetation has resulted in a concomitant elimination of wildlife across the 3400-acre Opportunity Ponds. Thus, soils, vegetation, wildlife, and wildlife habitat at Opportunity Ponds are injured.

8.2 Sources of Hazardous Substances

Approximately one million cubic yards of wastes are present in the Old Works Area. Hazardous substances are transported to groundwater by infiltrating precipitation and by

direct contact with contaminated alluvial material. The Old Works area is also a source of contamination for surface water and is discussed in Chapter 9.

Sources of hazardous substances to Smelter Hill groundwater are surface soils and the underlying bedrock. Surface contamination is most severe at the location of the former Smelter complex. In some locations in this area surface soils are highly contaminated to a depth of at least four feet.

On Smelter Hill, releases of wastes directly to the land surface and, in particular, releases of large volumes of process water, have resulted in extensive surface and sub-surface contamination. As precipitation infiltrates through contaminated surface soils and the unsaturated portion of the bedrock aquifer, hazardous substances are dissolved and transported to groundwater. Similarly, groundwater flowing through the fractured bedrock aquifer dissolves hazardous substances adhering to aquifer materials. Groundwater contamination extends to a depth of at least 200 feet below the land surface.

The total volume of waste materials in the Anaconda and Opportunity Ponds is approximately 725 million cubic yards, with Anaconda Ponds containing 290 million cubic yards and Opportunity Ponds containing 435 million cubic yards. Hazardous substances are leached from these materials and transported to groundwater. Leaching occurs as precipitation infiltrates through the tailings and as groundwater contacts the tailings. At Opportunity Ponds, about one-half of the tailings are part of the groundwater system. At Anaconda Ponds, it appears that only a small percentage of the tailings are saturated with groundwater.

Contact between tailings and groundwater at the Ponds is due, at least in part, to groundwater mounding attributable to the large volumes of water discharged to the Ponds. Groundwater mounding is slowly dissipating. At Anaconda Ponds, mounding may no longer exist. At Opportunity Ponds, a significant volume of tailings will remain in contact with groundwater even after groundwater mounding disappears, although the precise extent of this interaction post-mounding is uncertain.

Warm Springs Ponds contain about 19 million cubic yards of tailings, contaminated sediments, and sludges. Pond water seeps through contaminated Pond berms and bed sediments and transports contaminants to the underlying groundwater. Groundwater

generally flows north from the Ponds, contaminating coarse grained alluvial material, and discharges to the Clark Fork River and the Mill-Willow Bypass. Releases from Warm Springs Ponds to surface water are discussed further in Chapter 9.

8.3 CERCLA Response Actions

To date, a number of actions have been undertaken in the Anaconda area to reduce or control releases of hazardous substances.

At Old Works, 250,000 cubic yards of sludges were removed and disposed of on Smelter Hill. These sludges were formerly a source of hazardous substances to groundwater.

On Smelter Hill, 600,000 cubic yards of flue dust, which has been a significant contributor to Smelter Hill groundwater contamination, is being excavated, stabilized, and disposed of in an on-site repository. In addition, approximately 100 acres within the 600 acre industrial area was revegetated.

At Warm Springs Ponds, remediation work consisted or will consist of raising and strengthening of levees/dams, reconstruction of the Mill-Willow Bypass, and intercepting contaminated groundwater below Pond 1 to reduce releases of hazardous substances to the Clark Fork River and then treating the groundwater in Ponds 2 and 3. Pond 1 will be wet and dry-closed, meaning that exposed tailings are covered with water or soil. Although EPA has stated that it expects that its selected remedies at Warm Springs Ponds will be permanent, EPA will make a final decision on the fate of the Ponds after upstream cleanup.

Remedial Investigation/Feasibility Studies (RI/FS) for the Anaconda area are underway. At Old Works, a Record of Decision (ROD) was recently issued. With the exception of Warm Springs Ponds, a ROD for the remainder of the Anaconda area is anticipated in 1996. Based on a review of the RI/FS literature, an evaluation of actions implemented or planned at other sites in the Basin, consideration of ARCO's position, and discussions with EPA and MDHES personnel, the Natural Resource Damage Program identifies the following actions as likely to be implemented in the Anaconda area:

1) implementation of institutional controls to prohibit the use of groundwater in contaminated areas and to prohibit access to Opportunity and Anaconda Ponds;
2) limestone application over Opportunity and Anaconda Ponds for erosion control;

3) removal of waste, capping waste areas, and revegetation around the Old Works area; and
4) revegetation of an additional 300 acres within the industrial area on Smelter Hill.

8.4 Residual Injury

Response actions in the Anaconda area will not restore resources and services to baseline conditions, nor are they intended to. Actions at Old Works will address groundwater injury by removing and isolating contaminated materials and by decreasing infiltration of precipitation through contaminated soils and waste materials. This will significantly reduce loadings to the aquifer.

On Smelter Hill, response actions are expected to address the most highly contaminated areas. While this action will reduce metal loadings to groundwater, the degree of reduction is unknown. It is possible, even likely, that metal contamination in the saturated zone of the bedrock is so extensive that addressing surface sources of contamination will not significantly reduce contaminant concentrations.

The extent of groundwater injury at Opportunity Ponds and Anaconda Ponds will not decrease as a result of response actions. In addition, injury to soils, vegetation, wildlife habitat, and wildlife at Opportunity Ponds will go unmitigated.

At Warm Springs Ponds, wet and dry-closure at Pond 1 is expected to reduce metal loadings to groundwater. Groundwater injury caused by sources of contamination in Ponds 2 and 3 will remain.

8.5 Restoration Alternatives

8.5.1 Introduction

The following alternatives do not propose removal of waste sources at Old Works, Smelter Hill, Anaconda Ponds, Opportunity Ponds, or Warm Springs Ponds. Removal actions were considered but were rejected for further analysis at this time because of issues related to the volumes and characteristics of the materials involved. Furthermore, as discussed, response actions at Old Works, Smelter Hill, and Warm Springs Ponds are expected to mitigate groundwater injury, however slightly.

Pumping and treating contaminated groundwater at various locations in the area was also considered but rejected for further analysis at this time because of the volume of contaminated groundwater and the extent of contamination. In particular, consideration was afforded to establishing a line of wells at the toe of Opportunity Ponds in order to prevent the plumes of manganese, iron, sulfate, and TDS from extending beyond the Ponds. However, this would require pumping and treating very large volumes of groundwater indefinitely into the future. Consideration was also afforded to pumping and treating the plumes of arsenic, cadmium, and zinc beneath the Ponds. However, this would not address the source of contamination and, thus, would not accelerate recovery or diminish the amount of contaminated groundwater.

Instead of addressing natural resource injuries by removing source material, alternatives were developed that would reduce metal loadings to groundwater and provide limited wildlife habitat. This can be achieved by grading and revegetating Opportunity and/or Anaconda Ponds. Revegetation can mitigate groundwater injury by reducing infiltration through the tailings. In addition, revegetation will provide wildlife habitat where there is none presently.

Revegetation will require a cap over the tailings to isolate the tailings from the soil in which the vegetation is growing. It should be noted that this cap will require long-term maintenance. Wind erosion, root action, or deterioration of the cap materials may render the metals in the tailings accessible to the vegetation. If this occurs, it is possible that the Ponds would revert to their present state.

As discussed in Section 1.2.2, restoration actions will be coordinated to the maximum possible extent with CERCLA response actions. It is estimated that remedy will require a limestone cover for the Ponds. Issues, to the extent any exist, concerning the integration of this remedy with restoration actions will be addressed as part of a coordinated approach among restoration and response authorities.

8.5.2 Alternative 8A

This alternative proposes to reduce metal loadings to groundwater by revegetating both Opportunity and Anaconda Ponds. The key elements of this alternative include:

1) grading Opportunity and Anaconda Ponds to form 2.0% slopes;

2) covering Opportunity and Anaconda Ponds with a cap and soil;

3) revegetating the Ponds with grasses and small shrubs;

4) directing runoff to a sediment detention basin; and

5) natural recovery.

Grading Opportunity and Anaconda Ponds must precede an effort to revegetate the Ponds. First, grading would facilitate runoff from the Ponds, reducing infiltration. Second, without grading, the reduced transmissivity of the cap materials would cause water to pool on the surface preventing revegetation or killing existing vegetation.

It would also be necessary to collect and treat runoff from the Ponds. Without a collection system, runoff from the Ponds would erode and compromise the cap. Collected runoff would be treated in one, two, or several sediment detention basins, totalling 209 acre-feet. From the basin(s), water would be discharged to the Clark Fork River or to the wetlands that would be created under this alternative.

Capping the ponds to allow for revegetation will entail the placement of a filter fabric to form a capillary barrier between the tailings and the new soil. Next, a 6-inch fill layer comprised of 3-5% bentonite (a clay-like substance) is necessary to create a chemical barrier between the tailings and the new soil. The Ponds would then be covered with 12 inches of fill and 6 inches of growth media. The Ponds could not support trees or large shrubs due to the shallow 24-inch cap. Therefore, Opportunity Ponds will not resemble the wetlands community that existed prior to tailings deposition.

The borrow area, possibly located adjacent to Opportunity Ponds, will be reclaimed after excavation to form a wetlands area. The wetlands would provide a large habitat island. Water to fill the constructed wetlands area would come from groundwater infiltration or from runoff.

Restoration actions under this alternative will not restore resources and services to baseline in a reasonable time frame. Restoration to baseline conditions will occur when the metals in primary sources, i.e., tailings, and the metals in secondary sources, i.e., aquifer materials, have been transported out of the system. It is estimated this will take thousands or tens of thousands of years.

Revegetating Opportunity and Anaconda Ponds will provide substantial benefits even

if such an action does not accelerate the time frame for restoration to baseline. Grading and revegetating the ponds would reduce metal loadings to groundwater as less infiltration occurs. Thus, while groundwater would remain contaminated, concentration levels may be significantly lower than at present.

In addition, given the existing condition of Opportunity Ponds, a viable vegetative community would represent a substantial recovery of riparian resources. While revegetation of Opportunity Ponds would not represent baseline conditions and would not advance natural recovery, it would provide limited wildlife habitat where there is no such existing habitat.

8.5.3 Alternative 8B

Under this alternative Anaconda Ponds would not be covered. The key elements of this alternative are:

1) grading Opportunity and Anaconda Ponds to form 2.0% slopes;
2) covering Opportunity Ponds with a cap and soil;
3) revegetating Opportunity Ponds with grasses and small shrubs;
4) directing runoff from Opportunity Ponds to a sediment detention basin;
5) directing runoff from Anaconda Ponds to a lined storage pond;
6) constructing a treatment plant; and
7) natural recovery.

In this alternative Anaconda Ponds would not be revegetated. Instead, Anaconda Ponds would be graded and surface runoff would be collected and channeled to a 27-acre lined storage pond. A small treatment plant would be constructed to treat the contaminated runoff. All other elements of this alternative are identical to Alternative 8A.

Under this alternative metal loadings to contaminated groundwater beneath Anaconda Ponds would be somewhat reduced from present levels. Contaminant concentration levels, however, would remain elevated for the foreseeable future. Like Alternative 8A, this alternative would produce substantial benefits to Opportunity Ponds. Metal loadings would be lessened and revegetation would provide benefits to wildlife.

8.5.4 Alternative 8C

In this alternative, neither Opportunity Ponds nor Anaconda Ponds would be revegetated. The key elements of this alternative are:

1) grading Opportunity and Anaconda Ponds to form 2.0% slopes;
2) directing runoff from Opportunity and Anaconda Ponds to a lined storage pond;
3) constructing a treatment plant; and
4) natural recovery.

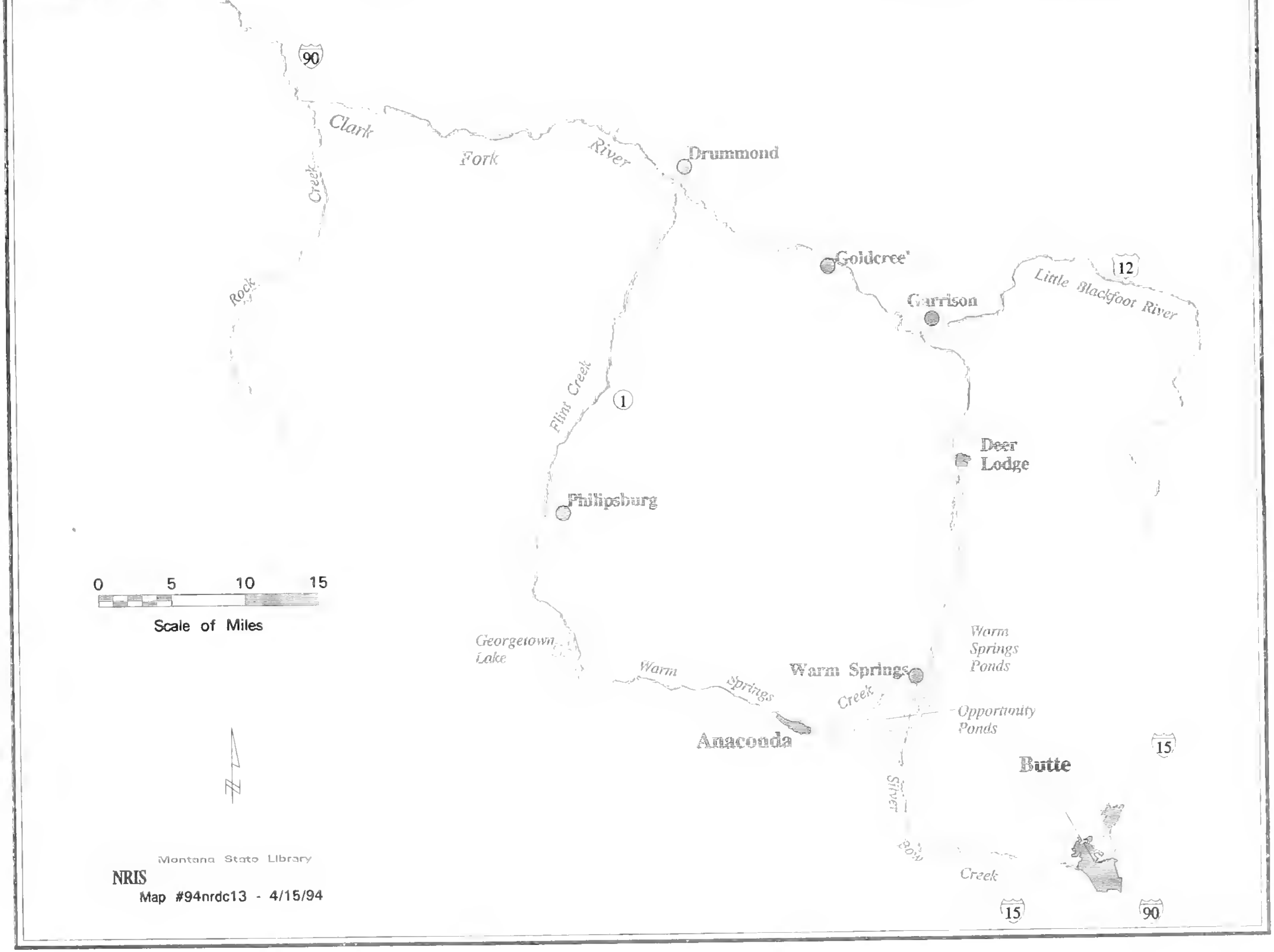
In this alternative the benefits of covering and revegetating the Ponds to reduce metal loadings would not be realized. However, grading and collecting surface runoff will lessen infiltration through the Ponds. A lined storage pond (or ponds), with a capacity of 209 acre-feet, would be constructed. A treatment plant (or plants) sized to handle 1.1 million gallons per day would be required to treat the contaminated runoff.

Under this alternative, metal loadings to groundwater would decrease slightly from present conditions as a result of grading the Ponds and directing runoff away from the Ponds. Injuries to wildlife and wildlife habitat would not be mitigated.

8.5.5 Alternative 8D

Under this alternative, no further action is taken at the site beyond the CERCLA response action. It is estimated that restoration of resources and services to baseline may occur in thousands or tens of thousands of years when all the metals have migrated out of the area.

Figure 9-1.
Clark Fork River



9.0 CLARK FORK RIVER AQUATIC AND RIPARIAN RESOURCES

9.1 Description of Site and Injury

Aquatic and riparian resources of the Clark Fork River from Warm Springs to Milltown Reservoir have been injured by the hazardous substances arsenic, cadmium, copper, lead, and zinc released from mining and mineral-processing operations in the Butte and Anaconda areas. This reach of the river is a unit of the Milltown Reservoir/Clark Fork River NPL Site.

The headwaters of the Clark Fork River are formed by Warm Springs Creek and the Mill-Willow Bypass. Approximately 124 miles downstream is the Milltown Reservoir, an impoundment created by Milltown Dam at the confluence of the Clark Fork and Blackfoot Rivers.

Silver Bow Creek carried wastes from mining and milling operations in the Butte area directly to the Clark Fork River and its floodplain prior to the construction of Warm Springs Ponds. Three ponds were constructed on Silver Bow Creek near the town of Warm Springs between 1918 and 1956 to treat wastes and associated contaminated sediments in Silver Bow Creek. The Ponds release hazardous substances to the Clark Fork River by way of the Mill-Willow Bypass. Mining and smelting wastes deposited along Warm Springs Creek near Anaconda also contribute hazardous substances to the Clark Fork River.

Large areas of the Clark Fork River's floodplain from Warm Springs to the Milltown Reservoir, including the river's banks, are contaminated by hazardous substances. Floodplain contamination consists of tailings, mixed alluvium and tailings, and contaminated soils. Tailings and contaminated soils are cycled back and forth between aquatic and riparian environments. Floodplain tailings and contaminated soils contaminate surface water and bed sediments through releases of hazardous substances by surface runoff, scouring during bank full and overbank high flows, and riverbank wasting and slumping. Similarly, hazardous substances are deposited on the floodplain during overbank high flows.

Benthic macroinvertebrates living in and on the riverbed have accumulated hazardous substances in their tissues. Consumption of benthic macroinvertebrates by trout results in exposure and injury, including death and reduced growth. Populations of otter, mink, and

raccoons that rely on fish and benthic macroinvertebrates in their diets are significantly reduced relative to baseline conditions.

Contaminated floodplain deposits have injured riparian resources, depriving wildlife of habitat. The most severe floodplain contamination, as determined by the frequency and extent of devegetated or sparsely vegetated tailings deposits, occurs between Warm Springs and Deer Lodge. In general, concentrations of hazardous substances in floodplain deposits and the occurrence of devegetated tailings decrease in a downstream direction. Like the floodplain, the severity of riverbed and bank contamination decreases with distance from the Ponds.

Natural resource injuries to the Clark Fork River from releases of hazardous substances is demonstrated in the following ways:

1) Surface water contains concentrations of hazardous substances that exceed criteria established for the protection of aquatic life and thresholds that have been demonstrated to cause injury to fish.

2) Bed sediments contain hazardous substances at concentrations that exceed baseline conditions by, on average, a factor of more than ten, and exceed concentrations that are expected to injure benthic macroinvertebrates.

3) Benthic macroinvertebrate tissues contain hazardous substances. Consumption of these contaminants by trout has been shown to caused reduced growth and survival.

4) Trout density is less than one-third baseline conditions due to exposure to contaminated surface water and consumption of contaminated benthic macroinvertebrates. Rainbow trout are largely absent from the Clark Fork River upstream of its confluence with Rock Creek.

5) Populations of otter, mink, and raccoons that rely on fish and benthic macroinvertebrates in their diets are significantly reduced relative to baseline conditions. Otter are completely absent from the Clark Fork River.

6) Approximately 400 acres of floodplain contain phytotoxic concentrations of hazardous substances and are therefore entirely or largely devoid of vegetation. These areas have no or little capacity to support viable wildlife populations.

7) Thousands of additional floodplain acres contain tailings and contaminated soils and are a continuing source of hazardous substances to aquatic and riparian resources.

9.2 Sources of Hazardous Substances

Numerous waste sources contribute to injuries in the Clark Fork River. These include sources to groundwater and surface water in Area One described in Chapter 3, and floodplain tailings and soils and bed sediments in Silver Bow Creek described in Chapter 4. Contaminated groundwater beneath the Opportunity Ponds and the Warm Springs Ponds are also sources to the Clark Fork River and are discussed in Chapter 8. Sources discussed in this chapter include tailings and contaminated soils in the Clark Fork River floodplain, bed sediments of the Clark Fork River, discharges from Warm Springs Ponds, and wastes along Warm Springs Creek.

The Clark Fork River floodplain from Warm Springs to Milltown Reservoir is contaminated by hazardous substances. The areal extent of floodplain contamination has been mapped as three different tailings/soils complexes (Table 1). The most contaminated areas are designated Complex I and contain, on average, 60 to 70 percent exposed tailings with little or no vegetation. Complex II areas contain, on average, 20 to 30 percent exposed tailings with sparse vegetation. The least contaminated areas are designated as other metals-enriched soils. Complex I covers 417 acres of floodplain from Warm Springs to just below Deer Lodge. Complex II covers 4,140 acres of floodplain from Warm Springs to just below Gold Creek. Field observation has confirmed that there is overlap in the Complex I and II units. That is, some of the Complex II areas are as severely devegetated as the Complex I areas. Metals-enriched soils cover approximately 9,000 additional acres of floodplain extending along the entire length of the river between Warm Springs and Milltown Reservoir.

Table 1 Tailings/Soils Complexes in the Clark Fork River				
COMPLEX	AREA (acres)	THICKNESS (feet)	VOLUME (cubic yards)	REGIONAL EXTENT
I) 60-70% exposed tailings with little or no vegetation	417	1.25	841,000	Warm Springs to just below Deer Lodge
II) 20-30% exposed tailings with sparse vegetation	4,140	0.3	2,004,000	Warm Springs to just below Gold Creek
Other metals-enriched soils	9,000	Unknown	Unknown	Warm Springs to Milltown Reservoir
TOTAL	13,557	Not Applicable	Unknown	Not applicable

As noted, tailings and contaminated soils and sediments are cycled between the floodplain and the River. Hazardous substances in the floodplain are released to surface water and bed sediments by surface runoff over exposed surfaces, scouring during bankfull and overbank high flows, and riverbank wasting and slumping. Contaminated bed sediments and floodplain deposits are also reentrained and redeposited on the floodplain by overbank high flows.

In addition, contaminated bed sediments migrate downstream by fluvial transport processes. During high flows the River carries a larger load of contaminated sediment downstream than under normal flow conditions.

Warm Springs Ponds, which partially treats the contaminated waters of Silver Bow Creek, discharges continuously to the Clark Fork River via the lower end of the Mill-Willow Bypass. The Ponds' discharges are a source of hazardous substances to the River. The Warm Springs Ponds' discharges are being addressed by CERCLA response actions and are discussed in Section 9.3.

Finally, wastes from smelting operations in the Anaconda area were deposited along Warm Springs Creek, which is a headwaters tributary of the Clark Fork River. Hazardous substances have entered Warm Springs Creek by surface runoff over waste sources and

during high flows that reentrain floodplain wastes. These wastes have been, and will be, addressed by CERCLA response actions as discussed in Section 9.3.

9.3 CERCLA Response Actions

To date, response actions have been undertaken to reduce or control releases of hazardous substances to the Clark Fork River. These include:

1) isolating wastes along Warm Springs Creek by levee reconstruction, detention basin construction, and floodplain engineering;
2) removing tailings in and reconstructing the Mill-Willow Bypass;
3) upgrading the treatment capacity and efficiency of Warm Springs Ponds; and
4) closing Warm Springs Pond 1, with installation of a groundwater collection and pumping facility to reduce the discharge of contaminated groundwater to the Clark Fork River.

The Remedial Investigation/Feasibility Study (RI/FS) for the Clark Fork River has not yet begun. A Record of Decision (ROD) selecting a preferred alternative is anticipated in 1999. The RI/FS will evaluate different remedial options for floodplain tailings, including removal with on-site or off-site disposal and in-situ immobilization of hazardous substances by a technique known as STARS (Streambank Tailings and Revegetation Study). STARS entails the addition of lime and other calcium compounds to tailings and contaminated soils and revegetating the amended area with acid and/or metal tolerant plant species, primarily grasses. Lime neutralizes acid pH conditions in tailings and contaminated soils, which immobilizes hazardous substances and permits the reestablishment of vegetation. By these mechanisms STARS seeks to prevent hazardous substances from reaching surface water by runoff or groundwater by leaching.

An action not directly associated with CERCLA, known as the Governor's Project, was undertaken to evaluate STARS techniques. Tailings along 1.5 miles of floodplain immediately downstream of the River's headwaters at Warm Springs were pulled away from the river, limed, and revegetated. Monitoring to evaluate the effectiveness of this action is ongoing.

Based on a review of the RI/FS literature, an evaluation of actions implemented or planned at other sites in the Basin, consideration of ARCO's position, and discussions with

EPA and MDHES personnel, the Natural Resource Damage Program (NRDP) identifies the following actions as likely to be implemented at the Clark Fork River:

1) tailings immediately adjacent to the Clark Fork River will be excavated and relocated to devegetated areas further away from the river;
2) tailings and associated contaminated soils, including relocated tailings, will be treated with lime and revegetated (STARS);
3) riverbanks in STARS-treated areas will be stabilized; and
4) grazing will be managed to protect STARS-treated floodplain areas.

It is estimated that the remedy will occur over approximately 400 acres of floodplain.

9.4 <u>Residual Injury</u>

The remedy will not return aquatic and riparian resources to baseline, nor is it intended to. After implementation of the remedy, sources of hazardous substances will remain, causing injuries to aquatic and riparian resources.

Hazardous substances not addressed by the remedy are located on the contaminated floodplain and the riverbed from Warm Springs to Milltown Reservoir. Sources include approximately 9000 acres of metals-enriched soils, 4100 acres of Complex II tailings, 400 acres of floodplain that will be treated by STARS, and many miles of riverbanks and riverbed.

In addition, notwithstanding the upgrading of treatment at Warm Springs Ponds, releases of hazardous substances to the Clark Fork River will continue to occur. These releases will cause hazardous substance concentrations in the River to exceed baseline conditions. On occasion, concentration levels will be greatly elevated, and this will result in exceedances of water quality criteria, sometimes by a substantial margin.

Remedial activities along Warm Springs Creek will greatly reduce releases of hazardous substances to the Creek. Therefore, sources of hazardous substances to Warm Springs Creek will not be discussed further in this chapter.

Important to a discussion of residual injury are the inherent limitations of STARS. STARS is a source control technique that seeks to reduce releases of hazardous substances to surface water and groundwater by establishing a vegetative cover on contaminated floodplain tailings and soils; thereby reducing releases of hazardous substances to surface water and

groundwater. Even if STARS accomplishes what is intended, significant residual injury will exist. Hazardous substances will remain in floodplain tailings and soils at concentrations exceeding baseline conditions. These concentrations will be phytotoxic to many native species. This, and STARS' dependence on acid and/or metals tolerant grass and shrub species for revegetation, will result in poor vegetative diversity and a continuing reduction in wildlife habitat over the STARS-treated area.

Additionally, hazardous substances residing in the STARS treated floodplain will be eroded and remobilized by storm-event and snowmelt runoff and by overbank high-flows. Exposed soils will exist within the STARS treated area since vegetation cannot completely cover the land surface. Erosion will occur from these exposed areas of the floodplain and, to a lesser extent, from areas that are revegetated. Contamination of bed sediments and surface water will continue to occur as a result of these processes.

Finally, stream channel migration will, over time, intercept STARS-treated floodplain materials and remobilize contaminated floodplain soils, thereby contaminating bed sediments and surface water.

An additional concern is the effectiveness of STARS in maintaining a permanent vegetative cover. At present, NRDP believes there is a risk that over time the neutralization capacity of lime-amended soils will be depleted, causing pH levels to decrease and vegetation to die. In such an event, wildlife habitat would be lost and hazardous substances would become more available to remobilization by surface runoff and overbank high flows.

In conclusion, after implementation of CERCLA response actions, aquatic and riparian resources will remain injured. Concentrations of hazardous substances in surface water will exceed baseline. Hazardous substances in contaminated riverbed sediments will continue contaminating benthic macroinvertebrates, thereby injuring trout and other animals that rely on benthic macroinvertebrates in their diet. Trout populations will remain depressed compared to baseline conditions due to the continuing contamination of surface water, bed sediments, and benthic macroinvertebrates.

Residual injury to riparian resources will exist notwithstanding an effective STARS remedy. While vegetation will be reestablished on approximately 400 acres, the use of metals and/or pH tolerant grass and shrub species will result in a continuing reduction in

vegetative diversity, the number of riparian habitat layers, and the number of viable wildlife species.

9.5 Restoration Alternatives

9.5.1 Introduction

As a preliminary matter, it should be noted what is not proposed by the following restoration alternatives. First, no alternative proposes to remove all floodplain contamination. As presented in Table 1, at least 13,000 acres of floodplain along the entire length of the Clark Fork River between Warm Springs and Milltown Reservoir is contaminated. Alternatives are proposed that remove the most significant sources of contamination. While removal of all floodplain contamination was considered, it was rejected for further analysis.

Second, no alternative proposes to remove bed sediments. Among the reasons for rejecting bed sediments removal for detailed consideration are that it would be necessary to construct facilities over 120 miles of river to dewater the sediments and treat the contaminated water. In addition, since floodplain contamination is proposed to be left in-place, bed sediments would be recontaminated as floodplain contamination migrates to the River.

Third, no alternative specifically targets removal and reconstruction of contaminated banks below Deer Lodge. Bank contamination between the Ponds and Deer Lodge is a significant source of hazardous substances to the River and warrants removal consideration. Bank removal below Deer Lodge was rejected for further analysis at this time because it is not as significant a source as banks upstream. Removal of floodplain contamination will indirectly address riverbank contamination below Deer Lodge.

Understanding and analyzing the following restoration alternatives requires that a distinction be made between riparian areas determined to be injured by hazardous substances and riparian areas identified as a source of hazardous substances to injured aquatic resources. Four-hundred acres of riparian resources were determined to be injured. Therefore, only 400 acres of floodplain can be restored to a baseline condition. The remaining areas of contaminated floodplain were not determined to be injured but were determined to constitute a source of hazardous substances to aquatic resources. Actions in these areas would be

undertaken not to restore riparian resources but to remove a source of hazardous substances to injured aquatic resources.

As discussed in Section 1.2.2, restoration planning will be coordinated to the maximum possible extent with response action planning. NRDP will endeavor to implement restoration actions in conjunction with the response action. Such coordination seeks to ensure that restoration actions do not conflict with the chosen response action. In the preceding sections NRDP estimates that STARS will be a component of the remedy for the Clark Fork River. Since a remedy that utilizes STARS will not result in the restoration of resources and services, alternatives are proposed that would result in the undoing of the remedy (assuming STARS is, in fact, chosen) if STARS is implemented prior to the restoration action. As noted, it is NRDP's intention that such a conflict be avoided by coordinating with CERCLA response authorities. Notwithstanding the foregoing, the restoration alternatives presented would be worthy of consideration if the anticipated remedy occurs or does not occur as a result of coordination.

9.5.2 Alternative 9A

This alternative contemplates extensive removal of contaminated floodplain and riverbank materials that are sources of hazardous substances to the Clark Fork River and restoration of riparian resources. The key elements of this alternative include:

1) excavating 4,557 acres of tailings and related floodplain contamination;
2) partial backfilling of 417 acres of excavated floodplain;
3) covering 417 acres of excavated floodplain with six inches of growth media;
4) revegetating excavated floodplain areas;
5) removing highly contaminated riverbanks between Warm Springs and Deer Lodge;
6) reconstructing riverbanks between Warm Springs and Deer Lodge;
7) disposing of excavated materials outside the floodplain;
8) flow augmentation; and
9) natural recovery.

Under this alternative, 4,557 acres of tailings and associated floodplain contamination containing approximately 2,845,000 cubic yards of material would be excavated. Excavated

materials would be disposed of outside the floodplain.

Following excavation, 417 acres of the excavated floodplain would be backfilled and covered with six inches of growth media. Four hundred acres, the extent of riparian resource injury, would be restored to a baseline riparian habitat of shrub/forest and agricultural (grass/forb) habitat types. Species of native grasses, shrubs, and trees and replanting densities would be comparable to a baseline condition. The remaining 4,157 acres of floodplain that are excavated to reduce releases of hazardous substances to the Clark Fork River would be revegetated to existing vegetative conditions.

Riverbanks between Warm Springs and Deer Lodge that are located in Complex I and Complex II floodplain would be excavated to remove contaminated bank sediments. Banks would be excavated 10 feet into the floodplain over the 27 miles in this reach, and then reconstructed to a baseline condition. Between Deer Lodge and Gold Creek, revegetation of excavated floodplain areas would address riverbank stabilization. Riverbank removal, reconstruction, and stabilization would reduce releases of hazardous substances to surface water and bed sediments.

To further address residual surface water and riverbed contamination, flows in the Clark Fork River would be augmented by 100 cubic feet per second for nine months (mid-June to mid-March) each year. This would be accomplished by acquiring approximately 54,298 acre-feet of water. Flow augmentation would improve water quality by diluting hazardous substances resulting from residual floodplain and riverbed contamination and releases from the Warm Springs Ponds. By entraining sediment, higher flows would also result in less sedimentation of the riverbed. This would reduce exposure of benthic macroinvertebrates to hazardous substances.

Under this alternative, riparian resources would substantially recover as replanted vegetation matures. Revegetated floodplain areas would provide substantially improved wildlife habitat in about 20 years as native shrubs and grasses mature. Wildlife habitat close to a baseline condition would be achieved in approximately 50 years, the length of time necessary for cottonwood groves that are a significant component of the riparian shrub/tree habitat to achieve substantial growth.

Aquatic resources would substantially recover in ten to twenty years. By removing

the most severe and accessible areas of floodplain and riverbank contamination, the intensity and frequency of loadings of hazardous substances to the Clark Fork River would be measurably reduced. Source removal actions in upstream reaches of the River would benefit downstream reaches by reducing the migration of hazardous substances. Flow augmentation would ameliorate, but not eliminate, the toxicity of residual surface water and bed sediment contamination. Trout populations would increase because of the overall reduction in hazardous substance loadings to the Clark Fork River.

Despite the level of effort contemplated by this alternative, contaminant sources would remain due to the extensive and ubiquitous nature of floodplain and riverbed contamination. Over 9,000 acres of metals-enriched floodplain would not be excavated and would remain a source of hazardous substances to the Clark Fork River. The bed of the River between Warm Springs and Milltown Reservoir would remain contaminated and would therefore continue to expose and contaminate benthic macroinvertebrates and surface water. Banks that are not removed would also remain a source of hazardous substances. Releases from Warm Springs Ponds would continue. Given the residual floodplain and riverbed contamination under this alternative, natural resources and services would not be restored to baseline conditions for hundreds of, or possibly a thousand or more, years--the time required for natural processes to remove remaining contamination from the Clark Fork River and its floodplain.

9.5.3 <u>Alternative 9B</u>

This alternative removes less floodplain and riverbank contamination than Alternative 9A while restoring riparian resources. The key elements of this alternative include:

1) excavating 831 acres of tailings and related floodplain contamination;
2) disposal of excavated materials outside the floodplain;
3) partial backfilling of 417 acres of excavated floodplain;
4) covering 417 acres of excavated floodplain with six inches of growth media;
5) revegetating excavated floodplain areas;
6) stabilizing riverbanks between Warm Springs Ponds and Deer Lodge;
7) flow augmentation; and
8) natural recovery.

Under this alternative, 831 acres of tailings and associated floodplain contamination would be removed. This includes 417 acres of Complex I tailings and 10% of the most severely contaminated Complex II tailings, or 414 acres, representing the most significant source of floodplain contamination to the River. The volume of tailings that would be excavated is 1,041,400 cubic yards. 417 acres of floodplain would be partially backfilled with clean material and covered with six inches of growth media to facilitate revegetation. As in Alternative 9A, 400 acres would be restored to a baseline riparian condition. The remaining 431 acres of excavated floodplain would be revegetated to its existing vegetative condition.

Riverbanks between Warm Springs and Deer Lodge that are not addressed by remedy would be stabilized by revegetating with shrubs.

Like Alternative 1, excavated floodplain tailings would be disposed of outside the floodplain. Flow augmentation would be utilized to address residual riverbed and surface water contamination.

Under this alternative, recovery and restoration of riparian resources would occur in the same time frame as under Alternative 9A. Specifically, substantial recovery would occur within 20 years as vegetation matures; restoration to baseline would occur in approximately 50 years.

Aquatic resource injuries would not be mitigated to the same extent under this alternative as under Alternative 9A. This alternative removes significantly less floodplain contamination than Alternative 9A, and no bank contamination would be removed except that which is associated with floodplain removal. Accordingly, the intensity and frequency of loadings of hazardous substances to the River from surface runoff, bankfull and overbank high flows, and bank slumping and wasting would be greater under this alternative than Alternative 9A. Still, this alternative would reduce contaminant concentrations relative to existing conditions, which would result in an increase in trout populations. While trout populations would not recover to the same level as under Alternative 9A, recovery would be substantial when compared to existing conditions. The increase in population levels would be manifested in approximately 20 years.

Given the existence of significant floodplain, bank, and bed sediment contamination

remaining under this alternative, resources and services would not be restored to baseline conditions for many centuries -- the amount of time that would be required for natural processes to remove hazardous substances from the Clark Fork River and its floodplain.

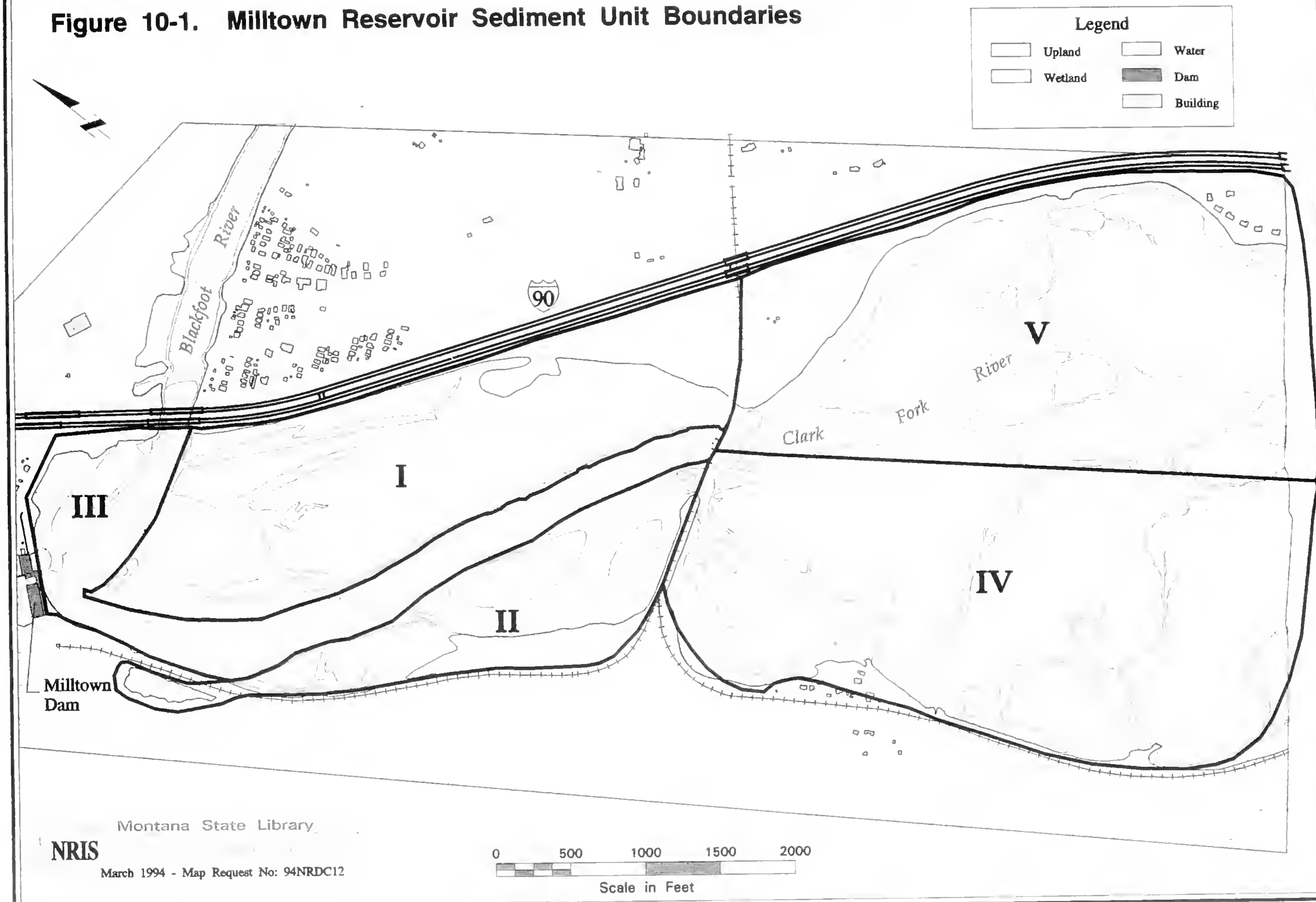
9.5.4 Alternative 9C

In this alternative, no further action is taken beyond the CERCLA response action. Four-hundred acres of devegetated or largely devegetated floodplain areas would have been treated by STARS to reduce runoff. Thousands of acres of contaminated floodplain would remain a source of hazardous substances to surface water. Bed and bank sediments would remain contaminated the entire length of the Clark Fork River. Releases of hazardous substances from Warm Springs Ponds would continue.

The STARS-remedy will partly restore wildlife habitat by revegetating with a few grass and shrub species. However, this action would not return riparian resources to a baseline condition. Concentrations of hazardous substances in STARS-treated areas will be phytotoxic to many species of native shrubs and grasses. Reestablishment of vegetation indicative of baseline will depend on natural erosional processes to remove contamination. This will occur over hundreds or even thousands of years.

The Clark Fork River would remain contaminated as long as extensive floodplain contamination exists and remains a source of hazardous substances to aquatic resources. Aquatic resources and services would not be restored for thousands of years, the amount of time required for erosion to remove floodplain contamination. Over time, however, recovery would occur as the amount of floodplain contamination decreases and the severity of impacts to aquatic resources lessens. It is difficult to estimate the time that would be required to achieve either level of substantial recovery that would occur under Alternatives 9A and 9B. Clearly, removal of sources of contamination achieves something that would require hundreds, if not thousands, of years of natural processes to achieve.

Figure 10-1. Milltown Reservoir Sediment Unit Boundaries



10.0 MILLTOWN GROUNDWATER RESOURCES

10.1 Description of Site and Injury

Milltown Dam was constructed in 1907-1908 at the confluence of the Clark Fork and Blackfoot Rivers, forming Milltown Reservoir. The dam is approximately 124 miles downstream from the Clark Fork River's headwaters near Warm Springs Ponds. The Reservoir is part of the Milltown Reservoir/Clark Fork River NPL site.

Approximately 6.6 million cubic yards of contaminated sediments have been deposited in the reservoir as a result of the downstream transport of mining, milling, and smelting wastes from the Butte and Anaconda areas. Consequently, the reservoir's storage capacity has been largely depleted, and much of the sediment load currently carried by the Clark Fork and Blackfoot Rivers passes through the reservoir. At present, the reservoir covers approximately 180 acres and has a storage capacity of about 800 acre-feet.

Reservoir sediments contain concentrations of hazardous substances significantly greater than baseline, including arsenic (32 times baseline), copper (62 times baseline), and zinc (67 times baseline). Hazardous substances released from these sediments have contaminated the groundwater underlying and adjacent to the Milltown Reservoir. In November 1981, community wells at Milltown were found to contain groundwater with arsenic concentrations as much as ten times the drinking water standard.

The groundwater system at Milltown is comprised of the groundwater in saturated reservoir sediments and the underlying alluvial material. Reservoir sediments are comprised of fine-grained sand, silt, and clay and range in thickness from as much as 25 feet immediately behind the dam to a few feet at the upstream end of the impoundment. In general, sediments thin in an upstream direction. These sediments overlie the original coarse alluvial floodplain material. The thickness of the alluvium underlying the reservoir sediments is unknown. Just north of the reservoir the alluvium is 30 feet thick, extending to 160 feet thick near the town of Milltown. The water table in the reservoir sediments is typically 10 to 15 feet higher than the water table beneath the town of Milltown. Reservoir water saturates the exposed and submerged fine-grained reservoir sediments and flows towards the town of Milltown by moving both northward and downward into the underlying

coarse alluvium. The groundwater then trends to the northwest and down the Clark Fork River Canyon.

Groundwater injury has been demonstrated by the presence of arsenic, iron, manganese, and total dissolved solids (TDS) at concentrations that exceed primary and secondary drinking water standards. Arsenic concentrations are 20 times the drinking water standard. The volume of contaminated groundwater is approximately 4,410 acre-feet. The annual flux of contaminated groundwater is estimated to be 177,100 acre-feet per year for manganese and 27,000 acre-feet per year for arsenic.

10.2 Sources of Hazardous Substances

The source of groundwater contamination is the fine-grained sediments in Milltown Reservoir. Contaminants are released as water flows through the sediments. Contaminated groundwater carries contaminants from the reservoir sediments to the underlying sand, gravel, and cobble alluvial aquifer.

The Milltown Reservoir Sediments Draft Site Remedial Investigation delineated five sediment accumulation areas. These areas differ in sediment thickness, the amount of sediment arsenic contamination, and arsenic concentrations in sediment porewater (groundwater).

Three adjacent deposition areas are generally contiguous with the extent of contaminant plumes and therefore represent a significant source of groundwater contamination. One of these sediment areas (area III) contains approximately 480,000 cubic yards of sediments. It is coextensive with the Clark Fork River channel and extends upstream from the dam approximately one mile. The second area (area I) contains approximately 2,640,000 cubic yards of sediments and is located between the River and the interstate highway, again extending upstream from the dam approximately one mile. The third area (area II) contains approximately 760,000 cubic yards of sediments and is located south of the river channel. Together these areas contain approximately 3,880,000 cubic yards of sediments, about sixty percent of the total amount of sediments in Milltown Reservoir.

Two other sediment deposition areas are located upstream of the main contaminant plumes. These areas (IV and V) contain approximately 1,200,000 and 1,520,000 cubic

yards, respectively, of contaminated sediments. These sediments range from two to twelve feet in thickness. As indicated by porewater arsenic concentrations and the absence of contaminant plumes, these sediments appear to contribute much less to the overall groundwater injury in the alluvium and sediments downstream than the sediments in areas I, II, and III.

Releases of contaminants from reservoir sediments are believed to result from two geochemical processes. One mechanism is the reduction of oxide minerals in the lower 15 to 20 feet of sediments. Another mechanism is the alternating oxidation and reduction of sulfide minerals in the upper 2 to 10 feet of sediments. The second process has been referred to as a "redox pump" because it is associated with alternating oxidizing and reducing conditions caused by fluctuating water levels in the reservoir. Montana Power Company's current operating license for the hydroelectric project limits the amount of water level fluctuation to a maximum of two feet in order to control releases from the "redox pump" process. Under normal operating conditions, water level generally fluctuates less than one foot.

10.3 CERCLA Response Actions

Response actions to date consist of the construction of a new public water supply system for the town of Milltown. This work was completed in 1985.

The Remedial Investigation/Feasibility Study (RI/FS) for Milltown Reservoir is in progress. The primary issues are remediation of groundwater contamination and potential releases of hazardous substances to the Clark Fork River downstream. A Record of Decision selecting the remedy is anticipated in 1996. At this time, the range of alternatives that will be evaluated is not known. However, based on a review of the RI/FS literature, an evaluation of actions implemented and planned at other sites in the Basin, consideration of ARCO's position, and discussions with EPA and MDHES, the Natural Resource Damage Program (NRDP) identifies the following actions as likely to be considered at Milltown Reservoir:

1) institutional controls, such as well drilling restrictions, to prevent use of contaminated groundwater;
2) pumping and treating groundwater;

3) stabilization, reconstruction, or removal of Milltown Dam; and

4) sediment removal.

At the present time, NRDP is unable to estimate a remedy for the Milltown site. Remedy projections are made untenable by two related factors. First, the RI/FS process is entirely open at this point in time as it considers what approach to take insofar as remedial options are concerned. Second, characteristics unique to Milltown prevent NRDP from making a considered estimate of remedy right now. In particular, features of this site causing remedy estimates to be highly problematic include: 1) the proximity of the site to the Missoula aquifer, upon which the City of Missoula depends, 2) the existence of millions of cubic yards of contaminated sediments behind a nearly century old dam subject to safety concerns, and 3) the fact that at this site remedy is considering impacts to an area, namely downstream of Milltown, which is outside of the area of concern for restoration purposes. In short, evaluation of all the relevant information needed for such an estimate of remedy simply does not enable an estimate to be made. The situation will become clearer as the RI/FS process proceeds.

In these circumstances, a projection of remedy runs the risk of adversely impacting response action and restoration planning. As noted, the situation at Milltown will be clarified relatively soon. When it is possible to do so and upon the release of a revised report, should such a report be necessary, NRDP will project remedy, describe residual injury, and develop restoration alternatives.

10.4 Residual Injury

Residual injury cannot be determined absent identification of a response action.

10.5 Restoration Alternatives

Without an estimation of remedy and residual injury, restoration alternatives cannot be developed because restoration must take into account the condition of the resource after the response action. By not presenting restoration alternatives in this report, the State of Montana is not forsaking a claim for restoration costs at Milltown.

NRDP is presently of the opinion that in order to achieve restoration or substantial recovery of resources at Milltown Reservoir, large volumes of contaminated sediments would have to be removed. This removal could be undertaken by either a response action or in the

course of restoration. Absent any removal of reservoir sediments, natural recovery would be relied upon to restore resources and services to baseline. Natural recovery would take many hundreds, if not thousands, of years.

11.0 REFERENCES

BUTTE GROUNDWATER

ARCO. 1993. Environmental Action Plan for the Upper Clark Fork River Basin. Summer, 1993.

Bioeconomics, Inc. 1994. Literature Review and Estimation of Municipal and Agricultural Values of Groundwater Use in the Upper Clark Fork River Drainage. Prepared for the Montana Natural Resource Damage Program. March 18, 1994.

Canonie Environmental Services Company. 1994. Draft Remedial Investigation Report for the Mine Flooding Operable Unit, Remedial Investigation/Feasibility Study. Prepared for ARCO. January, 1994.

Canonie Environmental Services Company. 1992. Safety Assessment Yankee Doodle Tailings Dam, Mine Flooding Operable Unit. March, 1992.

Canonie Environmental Services Company. 1994. Draft Feasibility Study Report for the Mine Flooding Operable Unit RI/FS. Prepared for ARCO. January, 1994.

Duffield, John and Neher, Chris. 1991. Market Value of Agricultural Water Leased for Instream Flows. Report to Montana Department of Fish, Wildlife and Parks. February, 1991.

Goldberg Geotechnical Consulting. 1990. Engineering Review, Yankee Doodle Tailings Ponds. Prepared for Montana Resources Inc. December 1, 1990.

Harding Lawson Associates (HLA). 1993. Seismic Stability Evaluation Yankee Doodle Tailings Dam, Butte, Montana. Prepared for Montana Resources. April 9, 1993.

International Engineering Company (IECO). 1981. Geotechnical & Hydrologic Studies, Yankee Doodle Tailings Dam, Butte, Montana. Prepared for The Anaconda Company. August, 1981.

Maest, A.S. and Metesh, J.J. 1993. Butte Groundwater Injury Assessment Report, Clark Fork River Basin NPL Sites, Montana. Prepared for State of Montana Natural Resource Damage Program. April, 1993.

OMB (Office of Management and Budget) 1992. Circular A-14. October 29, 1992.

Robert Peccia and Associates. 1991. Butte Water System Three Year Improvements Program. City of Butte. 1991.

U.S. Army Corps of Engineers. 1980. Phase I Inspection Report, National Dam Safety Program, Warm Springs Tailings Dams, Deer Lodge County, Montana, and Yankee Doodle Tailings Dam, Silver Bow County, Montana. February, 1980.

AREA ONE

ARCO. 1991. Silver Bow Creek/Butte Area CERCLA Site, Lower Area One, Butte, Montana. Expedited Response Action Engineering Evaluation/Cost Analysis. Public Comment Draft. Anaconda, MT. March 28, 1991.

ARCO. 1993. Environmental Action Plan for the Upper Clark Fork River Basin. Summer, 1993.

Chen-Northern and CH_2M Hill. 1990. Draft Final. Silver Bow Creek CERCLA Phase II Remedial Investigation. Data Summary. Volume I: Report. August, 1990.

ESA (ESA Consultants). 1992. Silver Bow Creek/Butte Area (Original Portion) Superfund Site, Lower Area One Operable Unit. Final Expedited Response Action Work Plan. Prepared for ARCO. Fort Collins, Colorado. April 30, 1992.

ESA (ESA Consultants). 1992. Draft Technical Memorandum. Groundwater Model. Phase I - Segment II. Silver Bow Creek/Butte Area (Original Portion) Superfund Site. Lower Area One Operable Unit. Expedited Response Action. Prepared for ARCO. Bozeman, Montana. December 30, 1992.

Harlan, Casey & Associates. 1991. Addendum to Engineering Evaluation/Cost Analysis. Silver Bow Creek/Butte Area CERCLA Site, Lower Area One, Butte, Montana. Expedited Response Action. Draft Final. Prepared for ARCO. November 1, 1991.

Harlan, Casey & Associates. 1991. Silver Bow Creek/Butte Area (Original Portion) CERCLA Site, Lower Area One, Butte, Montana. Expedited Response Action, Engineering Evaluation/Cost Analysis. November 1, 1991.

MKC (Morrison Knudsen Corporation). 1991. Silver Bow Creek/Butte Area NPL Site, Butte Priority Soils Operable Unit. Butte, Montana. Engineering Evaluation/Cost Analysis. Final Draft. Prepared for ARCO. November 18, 1991.

Maest, A.S. and Metesh, J.J. 1993. Butte Groundwater Injury Assessment Report, Clark Fork River Basin NPL Sites, Montana. Prepared for State of Montana Natural Resource Damage Program. April, 1993.

Multitech. 1987. Silver Bow Creek. Remedial Investigation Final Report. Appendix B, Part 1. Report. Ground Water and Tailings Investigation.

U.S. EPA. 1991. Final Responsiveness Summary, Lower Area One. Silver Bow Creek/Butte Area NPL Site, Butte, Montana. U.S. EPA Contract No. 68-W9-0021. Helena, Montana. February 14, 1991.

U.S. EPA. 1992. Enforcement/Action Memorandum. Lower Area One Operable Unit of the Silver Bow Creek/Butte Area (Original Portion) Superfund Site, Butte, Montana. December/January, 1991-1992.

<u>**SILVER BOW CREEK**</u>

ARCO. 1992. Silver Bow Creek Remediation Demonstration Project II, Streamside Tailings Treatability Study, Remedial Investigation/Feasibility Study, Streamside Tailings Operable Unit, Silver Bow Creek/Butte Area NPL Site, Butte, Montana. Prepared for ARCO. September, 1992.

ARCO. 1992. Silver Bow Creek Remediation Demonstration Project II. Streamside Tailings Treatability Study. Detailed Design Plans. Remedial Investigation/Feasibility Study. Streamside Tailings Operable Unit. Silver Bow Creek/Butte Area NPL Site. Butte, Montana. September, 1992.

ARCO. 1993. Environmental Action Plan for the Upper Clark Fork River Basin. Summer, 1993.

Canonie Environmental Services Corp. 1992. Silver Bow Creek/Butte Area NPL Site Streamside Tailings Operable Unit FS. Remedial Action Objectives Report and Treatment Technology Scoping Document. Prepared for ARCO. June, 1992.

Canonie Environmental Services Corp. 1992. Silver Bow Creek/Butte Area NPL Site, Streamside Tailings Operable Unit RI/FS. Remedial Action Objectives Report and Treatment Technology Scoping Document. Prepared for ARCO. June, 1992.

Canonie Environmental Services Corp. 1992. Silver Bow Creek/Butte Area NPL Site, Streamside Tailings Operable Unit RI/FS. Sampling and Analysis Plans -- 1992 Field Season. Prepared for ARCO. September, 1992.

Canonie Environmental Services Corp. 1993. Silver Bow Creek/Butte Area NPL Site Streamside Tailings Operable Unit RI/FS. 1992 Data Sampling Report. Prepared for ARCO. June, 1993.

Canonie Environmental Services Corp. 1993. Additional Data Interpretations, Remedial Investigation/Feasibility Study. Streamside Tailings Operable Unit. Silver Bow Creek/Butte Area NPL Site. Prepared for ARCO. November, 1993.

CH_2M Hill. 1989. Silver Bow Creek Flood Modeling Study. Prepared for State of Montana Department of Health and Environmental Sciences. November 30, 1989.

CH_2M Hill. 1992. Draft Technical Memorandum on Removal of Tailings and Associated Soils/Pond Bottom Sediments, Pond 1 and Below. Revision 1. Prepared for U.S. EPA, Region VIII. January, 1992.

EA ES&T. 1991. Draft Demonstration Project Plan, Silver Bow Creek Remediation Demonstration Projects. Prepared for ARCO. July, 1991.

EA ES&T. 1992. Sampling and Analysis Plan: Addendum 1 (draft). Silver Bow Creek Remediation Demonstration Project II Tailings and Soils Investigation. Remedial Investigation/Feasibility Study, Streamside Tailings Operable Unit. Silver Bow Creek/Butte Area NPL Site. Butte, MT. Prepared for ARCO. July, 1992.

Lipton, Joshua et al. 1993. Aquatic Resources Injury Assessment Report, Upper Clark Fork River Basin. Prepared for State of Montana Natural Resource Damage Program. June, 1993.

Lipton, J.H., Galbraith, H., and LeJeune, K. 1993. Terrestrial Resources Injury Assessment Report, Upper Clark Fork River Basin. Prepared for State of Montana Natural Resource Damage Program. September, 1993.

Neuman, D.R., Munshower, F.F., Dollhopf, D.J., Jennings, S.R., Schafer, W.M. and Goering, J.D. 1993. Streambank Tailings Revegetation, Silver Bow Creek, Montana. In *Planning, Rehabilitation and Treatment of Disturbed Lands. Sixth Billings Symposium, March 21-27, 1993. Volume II: Study of a Superfund Site - Butte/Anaconda and Silver Bow Creek.* Reclamation Research Unit Publ. No. 9301.

Reclamation Research Unit, Montana State University and Schafer and Associates. 1989. Technical Memorandum, Streambank Tailings and Revegetation Studies, Silver Bow Creek RI/FS. Results of Greenhouse Studies, Seed Mixes and Fertilizer Recommendations for STARS Pilot-Scale Treatability Studies. Prepared for CH_2M Hill, Inc. January 10, 1989.

Schafer and Associates, and Reclamation Research Unit, Montana State University. 1993. Streambank Tailings and Revegetation Studies. STARS Phase III. Draft Final Report. Volume I. Prepared for Montana Department of Health and Environmental Sciences. Helena, MT. April 9, 1993.

Schafer, William M., Goering, J.D., Grady, T.R., Spotts, E. and Neuman, D.R. 1993. Modeling the Fate and Transport of Metals in Surface Water at the Silver Bow Creek CERCLA Site. In *Planning, Rehabilitation and Treatment of Disturbed Lands. Sixth Billings Symposium, March 21-27, 1993. Volume II: Study of a Superfund Site - Butte/Anaconda and Silver Bow Creek.* Reclamation Research Unit Publ. No. 9301.

MONTANA POLE

ARCO. 1993. Environmental Action Plan for the Upper Clark Fork River Basin. Summer, 1993.

Citizens' Technical Environmental Committee. 1993. Minutes of CTEC Meeting, Tuesday, May 11, 1993.

52 Federal Register 17623 (July 22, 1987).

MDHES. U.S. EPA. 1993. Record of Decision. Montana Pole and Treating Plant NPL Site. Butte, MT. September, 1993.

Metesh, John J. 1993. Montana Pole Treatment Plant Groundwater Injury Assessment. Prepared for State of Montana Natural Resource Damage Program.

Montana DHES, and U.S. EPA. 1993. Proposed Plan. Montana Pole Superfund Site. May, 1993.

Montgomery, James M. 1993. Montana Pole and Treating Plant NPL Site Final Feasibility Study. Prepared for ARCO. March, 1993.

ROCKER

ARCO. 1993. Environmental Action Plan for the Upper Clark Fork River Basin. Summer, 1993.

Chen-Northern Inc., and CH_2M Hill Inc. 1989. Final Public Health and Environmental Assessment Data Summary Report. Rocker and Ramsay Areas. Silver Bow Creek CERCLA Site. Prepared for Montana Department of Health and Environmental Sciences. April, 1989.

Harding Lawson Associates. 1993. Draft Remedial Investigation Report. Silver Bow Creek/Butte Area NPL Site. Rocker Timber Framing and Treating Plant Operable Unit. Prepared for ARCO. November, 1991.

Keystone Environmental Resources, Inc. 1991. Draft Work Plan Remedial Investigation/Feasibility Study. Rocker Timber Framing and Treating Plant Operable Unit. Rocker, MT. Prepared for ARCO. June, 1991.

Keystone Environmental Resources, Inc. 1992. Preliminary Site Characterization Information Report. Rocker Timber Framing and Treating Plant Operable Unit. Rocker, MT. Prepared for ARCO. February, 1992.

Keystone Environmental Resources, Inc. 1992. Draft Data Summary Report Fall 1991 Sampling Program. Rocker Timber Framing and Treating Plant Operable Unit. Rocker, MT. Prepared for ARCO. February, 1992.

Keystone Environmental Resources, Inc. 1992. Draft Data Summary Report Fall 1991 Sampling Program. Rocker Timber Framing and Treating Plant Operable Unit. Rocker, MT. Appendices. Prepared for ARCO. February, 1992.

Keystone Environmental Resources, Inc. 1992. Draft Remedial Action Objectives and Development of Alternatives Report. Rocker Timber Framing and Treating Plant Operable Unit. Rocker, MT. Prepared for ARCO. March, 1992.

PTI Environmental Services. 1991. Preliminary Draft Rocker Timber Framing and Treating Plant Operable Unit, Historical Data Assessment Report. Prepared for ARCO. July, 1991.

PTI Environmental Services. 1993. Draft Summary/Data Validation/Data Usability Report. Silver Bow Creek/Butte Area NPL Site. Rocker Timber Framing and Treating Plant Operable Unit. 1992 Investigation. February, 1993.

Woessner, William W. 1993. Anaconda Groundwater Injury Assessment Report. Prepared for State of Montana Natural Resource Damage Program.

UPLANDS

Andreozzi, Bob. 1993. A&C Hill Survival Study and Report for 1985 through 1992, Headwater RC&D Forester.

ARCO. 1993. Environmental Action Plan for the Upper Clark Fork River Basin. Summer, 1993.

Bitterroot Native Growers, Inc. 1994. Wholesale Nursery Catalogue.

Holzworth, L., Schaefer, J., Green, G., and Wiersum, T. 1993. The City of Anaconda erosion control and stabilization of "C" Hill. In *Proc. of the Sixth Billings Symp: Planning, Rehabilitation and Treatment of Disturbed Lands.* Reclam. Resch. Unit Publ. No. 9301, Montana State University, Bozeman, Montana. March 21-27, 1993.

Lipton, J.H., Galbraith, H., and LeJeune, K., 1993. Terrestrial Resources Injury Assessment Report: Upper Clark Fork River Basin. Prepared for State of Montana Natural Resource Damage Program. September, 1993.

Montana State University. 1993. Anaconda Revegetation Treatability Studies Phase I: Literature Review, Reclamation Assessments, and Demonstration Site Selection. Prepared for ARTS Technical Committee. October 22, 1993.

Montana State University. 1993. Solicitation for Bid Document Smelter Hill (ARTS Site 9) Revegetation Demonstration Site. Bozeman, Montana, 1993.

PTI. 1991. Smelter Hill: Remedial Investigation and Feasibility Study, Preliminary Site Characterization Information. Prepared for ARCO. November, 1991.

ANACONDA GROUNDWATER

ARCO. 1993. Environmental Action Plan for the Upper Clark Fork River Basin. Summer, 1993.

EPA. 1993. Anaconda Smelter Superfund Site. Old Works/East Anaconda Development Area Operable Unit. Proposed Plan. Prepared by EPA, Region 8. September, 1993.

Environmental Science & Engineering, Inc. 1992. Anaconda Regional Water and Waste Operable Unit. 1991 Preliminary Site Characterization. Volume I - Text. Prepared for ARCO. March, 1992.

Environmental Science & Engineering, Inc. 1992. Anaconda Regional Water and Waste Operable Unit. Final Work Plan. Prepared for ARCO. April, 1992.

Environmental Science & Engineering, Inc. 1992. Anaconda Regional Water and Waste Operable Unit. Data Summary Report. Second Quarter 1992. Prepared for ARCO. October, 1992.

Environmental Science & Engineering, Inc. 1992. Anaconda Regional Water and Waste Investigation. Draft Hydrologic Conceptual Model. Prepared for ARCO. November, 1992.

Environmental Science & Engineering, Inc. 1992. Anaconda Regional Water and Waste

Investigation. Draft Hydrologic Conceptual Plan. Prepared for ARCO. December, 1992.

Environmental Science & Engineering, Inc. 1993. Anaconda Regional Water and Waste Operable Unit. Data Summary Report. Fourth Quarter 1992. Prepared for ARCO. April, 1993.

Environmental Science & Engineering, Inc. 1993. Anaconda Regional Water and Waste Operable Unit. Data Summary Report. First Quarter 1993. Prepared for ARCO. July, 1993.

Environmental Science & Engineering, Inc. 1993. Anaconda Regional Water and Waste Operable Unit. Data Summary Reports. Volume I: Technical Report Draft. Prepared for ARCO. October, 1993.

Environmental Science & Engineering, Inc. 1993. Anaconda Regional Water and Waste Operable Unit. Data Summary Reports. Second Quarter 1993. Volume II: Appendices Draft. Prepared for ARCO. October, 1993.

Environmental Science & Engineering, Inc. 1993. Data Summary Report for the Anaconda Regional Water and Waste Investigation. Third Quarter 1993. Volume I: Technical Report. Prepared for ARCO. January, 1994.

Environmental Science & Engineering, Inc. 1993. Anaconda Regional Water and Waste Operable Unit. Data Summary Reports. Third Quarter 1993. Volume II: Appendices Draft. Prepared for ARCO. January, 1994.

Lipton, J.H., Galbraith, H., and LeJeune, K., 1993. Terrestrial Resources Injury Assessment Report: Upper Clark Fork River Basin. Prepared for State of Montana Natural Resource Damage Program. September, 1993.

Montana Bureau of Mines and Geology. 1991. Butte & Anaconda Revisited. Special Publication 99.

Montana Natural Resource Damage Program. 1993. Groundwater Resources Injury Assessment Reports, Upper Clark Fork River Basin, Natural Resource Damage Program.

PTI Environmental Services. 1991. Smelter Hill Remedial Investigation and Feasibility Study. Phase I and II Soil Investigations. Data Summary/Data Validation/Data Usability Report. Volume I. Prepared for ARCO. September, 1991.

PTI Environmental Services. 1992. Draft Anaconda Soil Investigation. Data Summary/Data Validation/Data Usability Report. Prepared for ARCO. March, 1992.

PTI Environmental Services. 1992. Preliminary Site Characterization Information Report.

Anaconda Smelter NPL Site. Old Works/East Anaconda Development Area Operable Unit. Remedial Investigation/Feasibility Study. Prepared for ARCO. March, 1992.

PTI Environmental Services. 1993. Draft Anaconda Smelter NPL Site. Old Works/East Anaconda Development Area Operable Unit. Remedial Investigation Report. Volume II: Plates. Prepared for ARCO. February, 1993.

Special Resource Management, Inc. and Thomas, Dean & Hopkins, Inc. 1992. Anaconda Smelter NPL Site. Final Design Report for Arbiter and Beryllium Expedited Response Action. Prepared for ARCO. June, 1992.

TETRA TECH. 1985. Anaconda Smelter Remedial Investigation and Feasibility Study. Alluvium Investigation Data Report. Prepared for Anaconda Minerals Company. July, 1995.

TETRA TECH. 1986. Geochemistry Report. Prepared for Anaconda Minerals Company. July, 1986.

Woessner, William W. 1993. Anaconda Groundwater Water Injury Assessment Report. Prepared for State of Montana Natural Resource Damage Program. 1993.

CLARK FORK RIVER

ARCO. 1993. Anaconda Smelter NPL Site, Old Works Expedited Response Action, Final Construction Report. February, 1993.

ARCO. 1993. Environmental Action Plan for the Upper Clark Fork River Basin. Summer, 1993.

Bioeconomics, Inc. 1994. Literature Review and Estimation of Municipal and Agricultural Values of Groundwater Use in the Upper Clark Fork River Drainage. Prepared for the Montana Natural Resource Damage Program. March 18, 1994.

Canonie Environmental Services Corp. 1992. Silver Bow Creek/Butte Area NPL Site Streamside Tailings Operable Unit FS. Remedial Action Objectives Report and Treatment Technology Scoping Document. Prepared for ARCO. June, 1992.

CH_2M Hill, Chen-Northern, and Reclamation Research Unit. 1991. Draft Final: Clark Fork River Site Screening Study. Volume I - Text. Prepared for Montana Department of Health and Environmental Sciences. February, 1991.

CH_2M Hill, Chen-Northern, and Montana State University Reclamation Research Unit.

1991. Draft Final: Clark Fork River Screening Study. Volume III - Maps and Exhibits. Prepared for Montana Department of Health and Environmental Sciences. February, 1991.

CH_2M Hill. 1992. Draft Technical Memorandum on Removal of Tailings and Associated Soils/Pond Bottom Sediments, Pond 1 and Below. Revision 1. Prepared for U.S. EPA, Region VIII. January, 1992.

Duffield, John and Neher, Chris. 1991. Market Value of Agricultural Water leased for Instream Flows. Report to Montana Department of Fish, Wildlife and Parks. February, 1991.

EA ES&T. 1991. Draft Demonstration Project Plan, Silver Bow Creek Remediation Demonstration Projects. Prepared for ARCO. July, 1991.

EPA. 1993. Anaconda Smelter Superfund Site. Old Works/East Anaconda Development Area Operable Unit. Proposed Plan. Prepared by EPA, Region 8. September, 1993.

ESA Consultants. 1991. Discussion of Pond 3 Design and Operation. Warm Springs Ponds Operable Unit. Prepared for ARCO. April 26, 1991.

ESA Consultants. 1991. Draft. Evaluation of Alternatives for Pond 1 and Below. Silver Bow Creek/Butte Area NPL Site Warm Springs Ponds Operable Unit, Warm Springs, Montana. Prepared for ARCO. September 4, 1991.

Essig, D.A. and Moore, J.N.. 1992. Clark Fork Damage Assessment: Bed Sediment Sampling and Chemical Analysis Report. Prepared for the State of Montana Natural Resource Damage Program. 1992.

Lipton, Joshua et al. 1993. Aquatic Resources Injury Assessment Report, Upper Clark Fork River Basin. Prepared for State of Montana Natural Resource Damage Program. June, 1993.

Lipton, J.H., Galbraith, H., and LeJeune, K. 1993. Terrestrial Resources Injury Assessment Report, Upper Clark Fork River Basin. Prepared for State of Montana Natural Resource Damage Program. September, 1993.

MDHES and CH_2M Hill. 1989. Silver Bow Creek Investigation. Feasibility Study for the Warm Springs Ponds Operable Unit. Volume I - Report. Draft. October, 1989.

Montana Department of Fish, Wildlife & Parks. 1986. Application for Reservations of Water in the Upper Clark Fork River Basin. November, 1986.

Reclamation Research Unit, Montana State University and Schafer and Associates. 1989.

Technical Memorandum, Streambank Tailings and Revegetation Studies. Silver Bow Creek RI/FS. Results of Greenhouse Studies, Seed Mixes and Fertilizer Recommendations for STARS Pilot-Scale Treatability Studies. Prepared for CH_2M Hill, Inc. January 10, 1989.

Schafer and Associates. 1991. Final Monitoring Work Plan for the Clark Fork River Demonstration Project. Warm Springs, Montana. Prepared for the Governor of Montana. November 11, 1991.

Schafer and Associates, and Reclamation Research Unit, Montana State University. 1993. Streambank Tailings and Revegetation Studies. STARS Phase III. Draft Final Report. Volume I. Prepared for Montana Department of Health and Environmental Sciences. Helena, MT. April 9, 1993.

U.S. EPA. 1990. Record of Decision. Silver Bow Creek/Butte Area NPL Site, Warm Springs Ponds Operable Unit, Upper Clark Fork River Basin, Montana. September, 1990.

U.S. EPA. 1992. Record of Decision. Warm Springs Ponds Inactive Area Operable Unit (OU 12). Silver Bow Creek/Butte Area NPL Site (original portion). Clark Fork River Basin, Montana. U.S. Environmental Protection Agency, Region VIII. June, 1992.

MILLTOWN RESERVOIR

ARCO. 1993. Environmental Action Plan for the Upper Clark Fork River Basin. Summer, 1993.

ARCO. 1993. Milltown Reservoir Sediments Superfund Site. Remedial Investigation Report. Sections 5, 6 and 9. Anaconda, Montana. August, 1993.

Environmental Toxicology International. 1994. Continued Releases Risk Assessment. Milltown Reservoir Operable Unit. Milltown Reservoir Sediments Site. Prepared for U.S. EPA, Region 8. January, 1994.

U.S. Environmental Protection Agency, Region 8, Montana Office, Milltown Reservoir Superfund Site Report, EPA/MDHES. July 1992.

U.S. Environmental Protection Agency, Region 8, Montana Office, Milltown Reservoir Superfund Site Report, Risk Assessment Update. August, 1993.

Woessner, William W. 1993. Milltown Groundwater Injury Assessment Report. Clark Fork Natural Resource Damage Assessment. University of Montana. Missoula, Montana. March 10, 1993.

APPENDIX A

DETAILED COST ESTIMATES

INTRODUCTION

The following tables display cost estimates for each alternative listed in the report. Explanatory notes follow each table.

Costs were estimated for the foregoing alternatives by utilizing the cost estimating methodologies identified in the Proposed DOI regulations. Among the methodologies utilized to derive cost estimates are: 1) comparison methodology (Proposed 43 CFR §11.83(b)(2)(i)), 2) unit methodology (Proposed 43 CFR §11.83(b)(2)(ii)), and 3) standard time data methodology (Proposed 43 CFR §11.83(b)(2)(v)).

In particular, estimates were derived from the following general sources:

1) actual unit costs for work in the Basin;
2) actual market prices;
3) estimated unit costs for work in the Basin after verification for reasonableness;
4) actual unit costs for work outside the Basin;
5) unit costs for similar construction activities reported in the literature or vender quotes;
6) the 1992 Means Cost Guide for site work and landscaping.

The tables contain six columns. The description column identifies the particular work item to be costed. The next column breaks the work item into units and identifies the quantity of work to be undertaken per year. The third column is the unit cost. Next, the cost of the work item in 1994 dollars is displayed.

The fifth column identifies the years that work would occur. Year zero is 1994, year one is 1995, and so on. Work is assumed to begin no sooner than the year after the issuance of the pertinent Record of Decision (ROD) due to the intention of the Natural Resource Damage Program that remedy and restoration be coordinated. However, work will not always begin the year after the ROD. In some cases, work will be phased in order to take into account other remediation or restoration actions at the site or elsewhere in the Basin. The length of time to implement a particular item is based on what is reasonable under the circumstances.

The final column identifies the present worth of the work item based on a discount rate of seven percent as established in the DOI regulations. 43 CFR §11.84(e)(2). No work item extends beyond 50 years because application of the discount rate past that point produces insignificant increases in present worth.

The tables also display costs for contingencies and engineering and administration. Contingency costs, calculated at twenty percent of the alternative's present worth, simply reflect the uncertainty inherent in any cost estimate. Past practice has demonstrated that cost estimates of this nature are usually low. Typically, a greater volume of materials will need to be removed than originally anticipated and difficulties will arise during the operation. A value of twenty percent of the overall cost for contingencies is standard practice.

Engineering and administration costs, calculated at fifteen percent of the alternative's present worth, reflect costs of design, engineering, administration, and construction oversight. The fifteen percent figure is typical for construction of this nature.

All alternatives also include costs for State oversight of monitoring data. This cost is based on the average salary of a State of Montana employee likely to be assigned such a task. Expenses are not included in this figure and increases in wage rates are not taken into account. Monitoring would begin in year one. Thus, monitoring would serve two purposes--it would assist in restoration planning for those restoration actions that have not yet begun and it would track the condition of the resource into the future.

BUTTE HILL
ALTERNATIVE 2A

DESCRIPTION	QUANTITY PER YR	UNIT	UNIT COST	COST/YR 1994 DOLLARS	COST YEARS	PRESENT WORTH @ 7%*	TOTAL COST OF ALTERNATIVE
RK ITEM DESCRIPTION							
CONSTRUCT RESERVOIR	31,400	ACFT	$1,500 ACFT	$47,100,000	1	$47,100,000	
LEASE WATER TO OPERATE RESERVOIR	12,241	ACFT	$42 ACFT	$514,140	2-30	$5,899,000	
SUBTOTAL						$52,999,000	
STATE OVERSIGHT OF MONITORING DATA	1	YR	$30,000 YR	$30,000	1-50	$414,000	
SUBTOTAL						$414,000	
SUBTOTAL						$53,413,000	
CONTINGENCY @ 20%			20%			$10,683,000	
ENGINEERING AND ADMINISTRATION @ 15%			15%			$8,012,000	
TAL COST:ALTERNATIVE 2A							$72,108,000

YEAR ZERO IS 1994 TIME AND DATE OF PRINTOUT: 03:43 PM 18-Mar-94

BUTTE HILL
ALTERNATIVE 2B

DESCRIPTION	QUANTITY PER YR	UNIT	UNIT COST	COST/YR 1994 DOLLARS	COST YEARS	PRESENT WORTH @ 7%*	TOTAL COST OF ALTERNATIVE
ORK ITEM DESCRIPTION							
STATE OVERSIGHT OF MONITORING DATA	1	YR	$30,000 YR	$30,000	1-50	$414,000	
						================	
OTAL COST: ALTERNATIVE 2B							$414,000

* YEAR ZERO IS 1994 TIME AND DATE OF PRINTOUT: 03:43 PM 18-Mar-94

AREA ONE
ALTERNATIVE 3A

DESCRIPTION	QUANTITY PER YR	UNIT	UNIT COST		COST/YR 1994 DOLLARS	COST YEARS	PRESENT WORTH @ 7%*	TOTAL COST OF ALTERNATIVE
WORK ITEM DESCRIPTION								
1) EXCAVATE BRW TAILINGS	240,000	CY	$6.00	CY	$1,440,000	6-10	$4,210,000	
2) EXCAVATE PARROTT TAILINGS								
EXCAVATE AND STOCKPILE OVERBURDEN	280,000	CY	$6.00	CY	$1,680,000	6-8	$3,143,000	
EXCAVATE TAILINGS	95,000	CY	$6.00	CY	$570,000	6-8	$1,067,000	
REMOVE CITY/COUNTY SHOP COMPLEX	1	LS	$250,000	LS	$250,000	8	$146,000	
3) EXCAVATE MSD TAILINGS								
EXCAVATE AND STOCKPILE OVERBURDEN	112,000	CY	$6.00	CY	$672,000	6	$448,000	
EXCAVATE TAILINGS	115,500	CY	$6.00	CY	$693,000	6	$462,000	
4) HAULING AND DISPOSAL								
HAULING OF BRW TAILINGS	240,000	CY	$5.00	CY	$1,200,000	6-10	$3,508,000	
HAULING OF PARROTT TAILINGS	95,000	CY	$5.00	CY	$475,000	6-8	$889,000	
HAULING OF MSD TAILINGS	115,500	CY	$5.00	CY	$577,500	6	$385,000	
DISPOSAL OF BRW TAILINGS	240,000	CY	$15.00	CY	$3,600,000	6-10	$10,524,000	
DISPOSAL OF PARROTT TAILINGS	95,000	CY	$15.00	CY	$1,425,000	6-8	$2,666,000	
DISPOSAL OF MSD TAILINGS	115,500	CY	$15.00	CY	$1,732,500	6	$1,154,000	
5) BACKFILL EXCAVATED AREAS								
BACKFILL BRW AREA	240,000	CY	$12.00	CY	$2,880,000	6-10	$8,419,000	
BACKFILL PARROTT AREA	95,000	CY	$12.00	CY	$1,140,000	6-8	$2,133,000	
BACKFILL MSD AREA	115,500	CY	$12.00	CY	$1,386,000	6	$924,000	
6a) RECONSTRUCT BUTTE WWTP	1	LS	$30,000,000	LS	$30,000,000	5	$21,390,000	
6b) RECONSTRUCT CITY/COUNTY SHOP COMPLEX	1	LS	$750,000	LS	$750,000	9	$408,000	
7) INSTALL INTERCEPTION TRENCH - MSD AND SILVER BOW CREEK	9,385	LF	$200	LF	$1,877,000	10	$954,000	
8) EXPAND LIME PRECIPITATION TREATMENT								
EXPAND TREATMENT FACILITY (2.6 MGD)	1	LS	$10,400,000	LS	$10,400,000	10	$5,287,000	
INSTALL DISCHARGE LINE	6,770	LF	$12.00	LF	$81,240	10	$41,000	
TREATMENT PLANT O & M	1	YR	$1,258,400	YR	$1,258,400	11-50	$8,528,000	
TREATMENT PLANT SLUDGE DISPOSAL	1	YR	$2,175,420	YR	$2,175,420	11-50	$14,743,000	
9) CONSTRUCT SEDIMENT DETENTION BASIN								
BASIN CONSTRUCTION	50	AF	$1,500	AF	$75,000	11	$36,000	
BASIN O & M AND SEDIMENT DISPOSAL	1	YR	$210,600	YR	$210,600	12-50	$1,327,000	
SUBTOTAL							$92,792,000	
STATE OVERSIGHT OF MONITORING DATA	1	YR	$30,000	YR	$30,000	1-50	$414,000	
SUBTOTAL							$414,000	
SUBTOTAL							$93,206,000	
CONTINGENCY @ 20%			20%				$18,641,000	
ENGINEERING AND ADMINISTRATION @ 15%			15%				$13,981,000	
TOTAL COST:ALTERNATIVE 3A								$126,240,000

* YEAR ZERO IS 1994 TIME AND DATE OF PRINTOUT: 02:58 PM 18-Mar-94

AREA ONE - ALTERNATIVE 3A

Restoration actions would be coordinated with response actions under the Emergency Removal Action (ERA) at Lower Area One (LAO) and the Butte Priority Soils Operable Unit (BPSOU) Record of Decision (ROD). Excavation of tailings at LAO will be completed in the year 1999. At that time, two years of groundwater data collection will begin for designing a groundwater management system (2000 - 2001). Design and implementation of the groundwater management system and the site reclamation plan is anticipated to occur over the following three years (2002 - 2004). Response actions under the ERA would be fully implemented in the year 2004. Response actions for stormwater runoff would occur under the Butte Priority Soils Operable Unit (BPSOU) Record of Decision (ROD). The BPSOU ROD is anticipated in the year 1999. Completion of the BPSOU remedy is anticipated in the year 2004.

1) Excavation of the BRW tailings would begin in the year 2000, the year following completion of excavation at LAO under the ERA. Before excavating tailings under the Butte WWTP, a new WWTP would be constructed at another location. The design and construction of a new WWTP will take approximately 5 years (Item 7a) (1995 - 1999). The existing Butte WWTP and slag walls at the BRW, would be removed in the year 2000. Tailings excavation would occur over 5 years (2000 - 2004). The volume of excavated material is 1,200,000 cubic yards (CY). This is based on the 800,000 CY of tailings expanded by 50% to account for the additional material unavoidably removed during waste excavation (this is based on experience with removal actions elsewhere in the Clark Fork Basin). The groundwater interception system downgradient of the BRW anticipated under the ERA would be redesigned or eliminated to facilitate this excavation.

2) Excavation of the Parrott Tailings would begin in 2000, the year following issuance of the BPSOU ROD. Excavation would include 285,000 CY of tailings (190,000 CY, expanded by 50%) and 840,000 CY of overburden. Excavation would occur over three years (2000 - 2002).

3) Excavation of the Metro Storm Drain (MSD) tailings would occur in 2000, the year following the issuance of the BPSOU ROD. Excavation would include 115,500 CY of tailings (77,000 CY, expanded by 50%) and 112,000 CY of overburden.

4) Hauling costs are based on an average distance of 10 miles to a disposal site. Disposal costs are based on construction of a monofill in a location near Area One (although existing disposal sites could be used). Costs for BRW tailings are based on the volume of excavated tailings and associated material (Item 1, 1,200,000 CY). Costs for the Parrott Tailings are based on the volume of excavated tailings (Item 2, 285,000 CY). Costs for the MSD tailings are based on the volume of excavated tailings (Item 3, 115,500 CY). Hauling and disposal will occur in the same years as excavation.

5) Excavated areas will be backfilled to maintain the existing grade. Stockpiled overburden will be used for backfilling. Additional backfill material equal to the volumes of excavated tailings (Items 1, 2, and 3) will be required to maintain existing grades. Backfilling will occur in the same years as excavation.

6a) The new Butte WWTP would be constructed prior to demolition of the existing WWTP. Design and construction of the Butte WWTP would occur in years 1995 - 1999. This timeframe would allow removal actions to begin in 2000, the year following completion of ERA removal actions at LAO. This action and timeframe assumes that the WWTP would not be integrated with the lime-precipitation facility planned under the LAO ERA (Item 8). If these two facilities were built as one facility, the timeframe for both Items 6a and 9 would likely be substantially later.

6b) The City-County Shop Complex would be reconstructed in the year 2003, the year following removal of the Parrott Tailings. This assumes that the Complex would be reconstructed at its existing location.

7) The groundwater interception trench would be constructed using the single-pass method in the year 2004.

8) The lime-precipitation treatment facility that is constructed under the LAO ERA to treat 1 cubic foot per second (cfs) of groundwater would be expanded to treat 5 cfs of groundwater. The restoration cost includes only the cost of expanding the facility to treat an additional flow of 4 cfs (2.6 million gallons per day). A discharge line 6770 feet long would transport water back to the top of Silver Bow Creek (the confluence of the Metro Storm Drain and Blacktail Creek). Construction of the lime-precipitation facility is anticipated in the year 2004. Operation and maintenance (O & M) costs for the treatment facility include water quality monitoring, electricity, personnel, and periodic replacement of equipment. Sludge disposal costs are based solely on the volume of water treated under restoration (4 cfs).

9) The sediment detention basin would be unlined and is sized to contain sediment transported during a 100-year flow event. O & M costs were assumed to be the cost of excavation, hauling, and disposal of one-tenth the volume of the basins each year. The basin would be constructed immediately downstream of LAO. Construction would occur in 2005, the year following completion of all other remediation and restoration actions upstream.

AREA ONE
ALTERNATIVE 3B

DESCRIPTION	QUANTITY PER YR	UNIT	UNIT COST		COST/YR 1994 DOLLARS	COST YEARS	PRESENT WORTH @ 7%*	TOTAL COST OF ALTERNATIVE
WORK ITEM DESCRIPTION								
1) EXCAVATE PARROTT TAILINGS								
EXCAVATE AND STOCKPILE OVERBURDEN	140,000	CY	$6.00	CY	$840,000	6	$560,000	
EXCAVATE TAILINGS	126,000	CY	$6.00	CY	$756,000	6	$504,000	
2) EXCAVATE MSD TAILINGS								
EXCAVATE AND STOCKPILE OVERBURDEN	112,000	CY	$6.00	CY	$672,000	6	$448,000	
EXCAVATE TAILINGS	115,500	CY	$6.00	CY	$693,000	6	$462,000	
3) HAULING AND DISPOSAL								
HAULING OF PARROTT TAILINGS	126,000	CY	$5.00	CY	$630,000	6	$420,000	
HAULING OF MSD TAILINGS	115,500	CY	$5.00	CY	$577,500	6	$385,000	
DISPOSAL OF PARROTT TAILINGS	126,000	CY	$15.00	CY	$1,890,000	6	$1,259,000	
DISPOSAL OF MSD TAILINGS	115,500	CY	$15.00	CY	$1,732,500	6	$1,154,000	
4) BACKFILL EXCAVATED AREAS								
BACKFILL PARROTT AREA	126,000	CY	$12.00	CY	$1,512,000	6	$1,008,000	
BACKFILL MSD AREA	115,500	CY	$12.00	CY	$1,386,000	6	$924,000	
5) INSTALL INTERCEPTION TRENCH - MSD AND SILVER BOW CREEK	9,385	LF	$200	LF	$1,887,000	10	$954,000	
6) EXPAND LIME PRECIPITATION TREATMENT								
EXPAND TREATMENT FACILITY (2.6 MGD)	1	LS	$10,400,000	LS	$10,400,000	10	$5,287,000	
INSTALL DISCHARGE LINE	6,770	LF	$12.00	LF	$81,240	10	$41,000	
TREATMENT PLANT O & M	1	YR	$1,258,400	YR	$1,258,400	11-50	$8,528,000	
TREATMENT PLANT SLUDGE DISPOSAL	1	YR	$2,175,420	YR	$2,175,420	11-50	$14,743,000	
7) CONSTRUCT SEDIMENT DETENTION BASIN								
BASIN CONSTRUCTION	50	AF	$1,500	AF	$75,000	11	$36,000	
BASIN O & M AND SEDIMENT DISPOSAL	1	YR	$210,600	YR	$210,600	12-50	$1,327,000	
SUBTOTAL							$38,040,000	
STATE OVERSIGHT OF MONITORING DATA	1	YR	$30,000	YR	$30,000	1-50	$414,000	
SUBTOTAL							$414,000	
SUBTOTAL							$38,454,000	
CONTINGENCY @ 20%			20%				$7,691,000	
ENGINEERING AND ADMINISTRATION @ 15%			15%				$5,768,000	
TAL COST:ALTERNATIVE 3B								$52,330,000

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AREA ONE - ALTERNATIVE 3B

Restoration actions would be coordinated with response actions under the Emergency Removal Action (ERA) at Lower Area One (LAO) and the Butte Priority Soils Operable Unit (BPSOU) Record of Decision (ROD). Excavation of tailings at LAO will be completed in the year 1999. At that time, two years of groundwater data collection will begin for designing a groundwater management system (2000 - 2001). Design and implementation of the groundwater management system and the site reclamation plan is anticipated to occur over the following three years (2002 - 2004). Response actions under the ERA would be fully implemented in the year 2004. Response actions for stormwater runoff would occur under the Butte Priority Soils Operable Unit (BPSOU) Record of Decision (ROD). The BPSOU ROD is anticipated in the year 1999. Completion of the BPSOU remedy is anticipated in the year 2004.

1) Excavation of the Parrott Tailings would occur in 2000, the year following issuance of the BPSOU ROD. Excavation would include 126,000 CY of material (84,000 CY of tailings, expanded by 50% to account for the additional material unavoidably removed during waste excavation (this is based on experience with removal actions elsewhere in the Clark Fork Basin) and 140,000 CY of overburden. Overburden would be stockpiled on-site and used as backfill.

2) Excavation of the Metro Storm Drain (MSD) tailings would occur in 2000, the year following the issuance of the BPSOU ROD. Excavation would include 115,500 CY of material (77,000 CY of tailings, expanded by 50%) and 112,000 CY of overburden.

3) Hauling costs are based on an average distance of 10 miles to a disposal site. Disposal costs are based on construction of a monofill in a location near Area One (although existing disposal sites could be used). Costs for the Parrott Tailings are based on the volume of excavated tailings (Item 1, 126,000 CY). Costs for the MSD tailings are based on the volume of excavated tailings (Item 2, 115,500 CY). Hauling and disposal will occur in the same years as excavation.

4) Excavated areas will be backfilled to maintain the existing grade. Stockpiled overburden will be used for backfilling. Additional backfill material equal to the volumes of excavated tailings (Items 1 and 2) will be required to maintain existing grades. Backfilling will occur in the same years as excavation.

5) The groundwater interception trench would be constructed using the single-pass method in the year 2004.

6) The lime-precipitation treatment facility that is constructed under the LAO ERA to treat 1 cubic foot per second (cfs) of groundwater would be expanded to treat 5 cfs of groundwater. The restoration cost includes only the cost of expanding the facility to treat an additional flow of 4 cfs (2.6 million gallons per day). A discharge line 6770 feet long would transport water back to the top of Silver Bow Creek (the confluence of the Metro Storm Drain and Blacktail Creek). Construction of the lime-precipitation facility is anticipated in the year 2004. Operation and maintenance (O & M) costs for the treatment facility include water quality monitoring, electricity, personnel, and periodic replacement of equipment. Sludge disposal costs are based solely on the volume of water treated under restoration (4 cfs).

7) The sediment detention basin would be unlined and is sized to contain sediment transported during a 100-year flow event. O & M costs were assumed to be the cost of excavation, hauling, and disposal of one-tenth the volume of the basins each year. The basin would be constructed immediately downstream of LAO. Construction would occur in 2005, the year following completion of all other remediation and restoration actions upstream.

AREA ONE
ALTERNATIVE 3C

DESCRIPTION	QUANTITY PER YR	UNIT	UNIT COST	COST/YR 1994 DOLLARS	COST YEARS	PRESENT WORTH @ 7%*	TOTAL COST OF ALTERNATIVE
WORK ITEM DESCRIPTION							
STATE OVERSIGHT OF MONITORING DATA	1	YR	$30,000 YR	$30,000	1-50	$414,000	
)TAL COST:ALTERNATIVE 3C						$414,000	

SILVER BOW CREEK REGION
ALTERNATIVE 4A

DESCRIPTION	QUANTITY PER YR	UNIT	UNIT COST		COST/YR 1994 DOLLARS	COST YEARS	PRESENT WORTH @ 7%*	TOTAL COST OF ALTERNATIVE
WORK ITEM DESCRIPTION								
1) EXCAVATE FLOODPLAIN TAILINGS	606,600	CY	$6.00	CY	$3,639,600	2-6	$13,947,000	
2a) EXCAVATE STREAMBED	64,533	CY	$6.00	CY	$387,198	11-12	$356,000	
2b) CONSTRUCT BYPASS CHANNEL	58,080	FT	$22.50	FT	$1,306,800	11-12	$1,201,000	
3) HAULING AND DISPOSAL								
HAULING OF TAILINGS	883,800	CY	$5.00	CY	$4,419,000	2-6	$16,933,000	
HAULING OF SEDIMENTS	129,067	CY	$5.00	CY	$645,335	11-12	$593,000	
DISPOSAL OF TAILINGS	883,800	CY	$15.00	CY	$13,257,000	2-6	$50,800,000	
DISPOSAL OF SEDIMENTS	129,067	CY	$15.00	CY	$1,936,005	11-12	$1,779,000	
4) BACKFILL EXCAVATED FLOODPLAIN	408,900	CY	$12.00	CY	$4,906,800	2-6	$18,803,000	
5) TOPSOIL/GROWTH MEDIA COVER	177,789	CY	$10.00	CY	$1,777,890	2-6	$6,813,000	
6) REVEGETATE FLOODPLAIN								
SEED AND MULCH GRASSES/FORBS	165	AC	$825	AC	$136,125	2-6	$522,000	
HAND PLANT SHRUBS/TREES	55	AC	$2,310	AC	$127,050	2-6	$487,000	
7) RECONSTRUCT STREAM CHANNEL								
BACKFILL EXCAVATED STREAMBED	48,400	CY	$12.00	CY	$580,800	11-12	$534,000	
CONSTRUCT CHANNEL BEDFORMS	29,040	LF	$4.00	LF	$116,160	11-12	$107,000	
CONSTRUCT TYPE 2 STREAMBANKS	19,008	FT	$8.00	FT	$152,064	11-12	$140,000	
CONSTRUCT TYPE 3 STREAMBANKS	19,008	FT	$51.00	FT	$969,408	11-12	$891,000	
CONSTRUCT TYPE 4 STREAMBANKS	9,504	FT	$64.00	FT	$608,256	11-12	$559,000	
8) CONSTRUCT SEDIMENT DETENTION BASINS								
ABOVE DURANT CANYON	50	AF	$1,500	AF	$75,000	12	$33,000	
BASIN O & M AND SEDIMENT DISPOSAL	1	YR	$210,600	YR	$210,600	13-50	$1,234,000	
BELOW DURANT CANYON	100	AF	$1,500	AF	$150,000	12	$67,000	
BASIN O & M AND SEDIMENT DISPOSAL	1	YR	$421,200	YR	$421,200	13-50	$2,467,000	
SUBTOTAL							$118,266,000	
STATE OVERSIGHT OF MONITORING DATA	1	YR	$30,000	YR	$30,000	1-50	$414,000	
SUBTOTAL							$414,000	
SUBTOTAL							$118,680,000	
CONTINGENCY @ 20%			20%				$23,736,000	
ENGINEERING AND ADMINISTRATION @ 15%			15%				$17,802,000	
TAL COST:ALTERNATIVE 4A								$160,630,000

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SILVER BOW CREEK - ALTERNATIVE 4A

Floodplain excavation and restoration would begin the year following issuance of the Streamside Tailings Operable Unit Record of Decision (ROD), which is anticipated in 1995. Items for floodplain work are costed for five years (1996 - 2000). Stream channel excavation and reconstruction would begin the year after remediation and restoration actions have addressed upstream waste sources. Items for stream channel work are costed over two years (2005 - 2006).

1) The volume of excavated floodplain tailings will equal the total volume of floodplain tailings (3,003,000 CY), reduced by the volumes removed under remedy (430,200 CY from upper Silver Bow Creek; 220,000 CY from Durant Canyon; and 273,800 CY from lower Silver Bow Creek), and the volume removed along lower Silver Bow Creek during a demonstration project (57,000 CY). The final volume (2,022,000 CY) is expanded by 50% to account for the additional material unavoidably removed during waste excavation (this is based on experience with removal actions elsewhere in the Clark Fork Basin). The final volume of excavated material is 3,033,000 CY.

2a) Dewatering for streambed excavation will be accomplished by construction of a temporary bypass channel. Costs include excavation and backfilling of the channel.

2b) Eleven miles of stream channel will be excavated. The volume of material excavated will be 129,067 CY (11 miles x 20' wide x 2' deep x 1.5 expansion factor).

3) Hauling costs are based on an average distance of 10 miles to a disposal site. Disposal costs are based on construction of a monofill in a location near Silver Bow Creek (although existing disposal sites could be used). Hauling and disposal costs for floodplain tailings are based on the volume excavated under restoration (3,033,000 CY), plus the volume excavated under remedy that had been disposed of on-site, and expanded by 50% (1,386,000 CY). The total volume of floodplain material that will be disposed of is 4,419,000 CY. Hauling and disposal costs for streambed sediments are based on the amount excavated under restoration (Item 2a)(129,067 CY) plus the volume excavated under remedy, as expanded by 50% (129,067 CY) that had been disposed of on-site.

4) Excavated areas are backfilled to recontour the floodplain and create a riparian zone, on average, 300 feet wide, or 150' on each side of the Silver Bow Creek. The amount of backfill needed to recontour the floodplain is 50% of the amount excavated both under restoration and remedy from the floodplain above and below Durant Canyon. The percentage is based on the percentage of floodplain that is being revegetated to a grass/forb (agricultural) habitat type (75% of the floodplain will be restored to this habitat type; the growth media cover in Item 5 will account for the remaining 25%). The amount of material excavated from the floodplain above and below Durant Canyon is the volume in Item 3 (4,419,000 CY), less the amount removed from Durant Canyon (220,000 CY x 1.5)(Item 1). The amount of backfill required is 2,044,500 CY (4,089,000 CY x 50%).

5) The amount of growth media is based on a 6-inch cover of 1102 acres of excavated floodplain. The area of excavated floodplain is the total area of contaminated floodplain (1385 acres) less the areas excavated under remedy (133 acres along upper Silver Bow Creek; 48 acres in Durant Canyon, and 85 acres along lower Silver Bow Creek) and 17 acres along lower Silver Bow Creek excavated during a demonstration project. The volume of growth media required 888,947 CY (1102 acres x 43,560 square ft/acre x 0.5').

6) Revegetation costs are based on reconstructing 1102 acres of floodplain to 25% shrub/forest habitat (276 acres) and 75% grass/forbs (agricultural) habitat (826 acres). Costs include only the cost of seed and vegetation stock; labor costs are not included.

7) The amount of material needed to backfill the excavated streambed is 75% of the amount of bed material excavated (129,067 CY), or 96,800 CY. Channel bedforms (runs, riffles, and pools) are constructed during backfilling of the streambed. Streambank reconstruction costs are based on reconstruction of nine

miles of stream channel above and below Durant Canyon to 40% Type 2 banks ($8/FT), 40% Type 3 banks ($51/FT), and 20% Type 4 banks ($64/FT). The proportion of bank types is typical of a baseline condition.

8) The 50 acre-feet (AF) sediment detention basin constructed above Durant Canyon, and the 100 AF basin constructed below Durant Canyon would be unlined and are sized to contain sediment transported during a 100-year flow event. Operation and maintenance costs include the cost of excavation, hauling, and disposal of one-tenth the volume of the basins each year. Basins would be constructed the last year of work (2006).

SILVER BOW CREEK REGION
ALTERNATIVE 4B

DESCRIPTION	QUANTITY PER YR	UNIT	UNIT COST	COST/YR 1994 DOLLARS	COST YEARS	PRESENT WORTH @ 7%*	TOTAL COST OF ALTERNATIVE
WORK ITEM DESCRIPTION							
1) EXCAVATE FLOODPLAIN TAILINGS	422,400	CY	$6.00 CY	$2,534,400	2-6	$9,712,000	
2a) EXCAVATE STREAMBED	64,533	CY	$6.00 CY	$387,198	11-12	$356,000	
2b) CONSTRUCT BYPASS CHANNEL	58,080	FT	$22.50 FT	$1,306,800	11-12	$1,201,000	
3) HAULING AND DISPOSAL							
HAULING OF TAILINGS	422,400	CY	$5.00 CY	$2,112,000	2-6	$8,093,000	
HAULING OF SEDIMENTS	64,533	CY	$5.00 CY	$322,665	11-12	$297,000	
DISPOSAL OF TAILINGS	422,400	CY	$15.00 CY	$6,336,000	2-6	$24,279,000	
DISPOSAL OF SEDIMENTS	64,533	CY	$15.00 CY	$967,995	11-12	$890,000	
4) BACKFILL EXCAVATED FLOODPLAIN	211,200	CY	$12.00 CY	$2,534,400	2-6	$9,712,000	
5) TOPSOIL/GROWTH MEDIA COVER	70,341	CY	$10.00 CY	$703,410	2-6	$2,695,000	
6) REVEGETATE FLOODPLAIN							
SEED AND MULCH GRASSES/FORBS	65	AC	$825 AC	$53,625	2-6	$205,000	
HAND PLANT SHRUBS/TREES	22	AC	$2,310 AC	$50,820	2-6	$195,000	
7) RECONSTRUCT STREAM CHANNEL							
BACKFILL EXCAVATED STREAMBED	48,400	CY	$12.00 CY	$580,800	11-12	$534,000	
CONSTRUCT CHANNEL BEDFORMS	29,040	LF	$4.00 LF	$116,160	11-12	$107,000	
CONSTRUCT TYPE 2 STREAMBANKS	19,008	FT	$8.00 FT	$152,064	11-12	$140,000	
CONSTRUCT TYPE 3 STREAMBANKS	19,008	FT	$51.00 FT	$969,408	11-12	$891,000	
CONSTRUCT TYPE 4 STREAMBANKS	9,504	FT	$64.00 FT	$608,256	11-12	$559,000	
8) CONSTRUCT SEDIMENT DETENTION BASINS							
ABOVE DURANT CANYON	50	AF	$1,500 AF	$75,000	12	$33,000	
BASIN O & M AND SEDIMENT DISPOSAL	1	YR	$210,600 YR	$210,600	13-50	$1,234,000	
BELOW DURANT CANYON	100	AF	$1,500 AF	$150,000	12	$67,000	
BASIN O & M AND SEDIMENT DISPOSAL	1	YR	$421,200 YR	$421,200	13-50	$2,467,000	
SUBTOTAL						$63,667,000	
STATE OVERSIGHT OF MONITORING DATA	1	YR	$30,000 YR	$30,000	1-50	$414,000	
SUBTOTAL						$414,000	
SUBTOTAL						$64,081,000	
CONTINGENCY @ 20%			20%			$12,816,000	
ENGINEERING AND ADMINISTRATION @ 15%			15%			$9,612,000	
TAL COST:ALTERNATIVE 4B							$86,920,000

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SILVER BOW CREEK - ALTERNATIVE 4B

Floodplain excavation and restoration would begin the year following issuance of the Streamside Tailings Operable Unit Record of Decision (ROD), which is anticipated in 1995. Items for floodplain work are costed for five years (1996 - 2000). Stream channel excavation and reconstruction would begin the year after remediation and restoration actions have addressed upstream waste sources. Items for stream channel work are costed over two years (2005 - 2006).

1) The volume of floodplain tailings will equal 1,408,000 CY excavated from Silver Bow Creek above and below Durant Canyon (18 miles x 200' width x 2' depth). This volume is expanded by 50% to account for the additional material unavoidably removed during waste excavation (this is based on experience with removal actions elsewhere in the Clark Fork Basin). The final volume of excavated material is 2,112,000 CY.

2a) Dewatering for streambed excavation will be accomplished by construction of a temporary bypass channel. Costs include excavation and backfilling of channel.

2b) Eleven miles of stream channel will be excavated. The volume of material excavated will be 129,067 CY (11 miles x 20' width x 2' depth x 1.5 expansion factor).

3) Hauling costs are based on an average hauling distance of 10 miles to a disposal site. Disposal costs are based on construction of a monofill in a location near Silver Bow Creek (although existing disposal sites could be used). Hauling and disposal costs are calculated only for the volume of floodplain material (2,112,000 CY) and streambed sediments (129,067 CY) excavated under restoration (Items 1 and 2b). Materials excavated under remedy and disposed of on-site are assumed to have been sited at the edge of the floodplain and would not be excavated under restoration.

4) Excavated areas are backfilled to recontour the floodplain and create a riparian zone, on average, 300 feet wide, or 150 feet on each side of Silver Bow Creek. The amount of backfill needed to recontour the floodplain is 50% of the amount excavated from the floodplain above and below Durant Canyon. The percentage is based on the percentage of floodplain that is being revegetated to a grass/forb (agricultural) habitat type (75% of the floodplain will be restored to this habitat type; the growth media cover in Item 5 will account for the remaining 25%). The amount of excavated floodplain material is 2,112,000 CY (Item 1). The amount of backfill required is 1,056,000 CY.

5) The amount of growth media is based on a 6-inch cover of 436 acres of excavated floodplain or 351,707 CY (436 acres x 43,560 square ft/acre x 0.5').

6) Revegetation costs are based on reconstructing 436 acres of floodplain to 25% shrub/forest habitat (109 acres) and 75% grass/forbs (agricultural) habitat (327 acres). Costs include only the cost of seed and vegetation stock; labor costs are not included.

7) The amount of material needed to backfill the excavated stream bed is 75% of the amount of bed material excavated (129,067 CY), or 96,800 CY. Channel bedforms (runs, riffles, and pools) are constructed during backfilling of the streambed. Streambank reconstruction costs are based on reconstruction of nine miles of streamchannel above and below Durant Canyon to 40% Type 2 banks ($8/FT), 40% Type 3 banks ($51/FT), and 20% Type 4 banks ($64/FT). The proportion of bank types is typical of a baseline condition.

8) The 50 acre-feet (AF) sediment detention basin constructed above Durant Canyon, and the 100 AF basin constructed below Durant Canyon, would be unlined and are sized to contain sediment transported during a 100-year flow event. Operation and maintenance costs include the cost of excavation, hauling, and disposal of one-tenth the volume of the basins each year. Basins would be constructed the last year of work (2006).

SILVER BOW CREEK REGION
ALTERNATIVE 4C

DESCRIPTION	QUANTITY PER YR	UNIT	UNIT COST	COST/YR 1994 DOLLARS	COST YEARS	PRESENT WORTH @ 7%*	TOTAL COST OF ALTERNATIVE
WORK ITEM DESCRIPTION							
1) EXCAVATE FLOODPLAIN TAILINGS	554,900	CY	$6.00 CY	$3,329,400	2-4	$8,166,000	
2a) EXCAVATE STREAMBED	64,533	CY	$6.00 CY	$387,198	11	$184,000	
2b) CONSTRUCT BYPASS CHANNEL	29,040	FT	$22.50 FT	$653,400	11	$310,000	
3) HAULING AND DISPOSAL							
HAULING OF TAILINGS	770,000	CY	$5.00 CY	$3,850,000	2-4	$9,443,000	
HAULING OF SEDIMENTS	129,067	CY	$5.00 CY	$645,335	11	$307,000	
DISPOSAL OF TAILINGS	770,000	CY	$15.00 CY	$11,550,000	2-4	$28,328,000	
DISPOSAL OF SEDIMENTS	129,067	CY	$15.00 CY	$1,936,005	11	$920,000	
4) BACKFILL EXCAVATED FLOODPLAIN	385,000	CY	$12.00 CY	$4,620,000	2-4	$11,331,000	
5) TOPSOIL/GROWTH MEDIA COVER	117,236	CY	$10.00 CY	$1,172,360	2-4	$2,875,000	
6) REVEGETATE FLOODPLAIN							
SEED AND MULCH GRASSES/FORBS	109	AC	$825 AC	$89,925	2-4	$221,000	
HAND PLANT SHRUBS/TREES	36	AC	$2,310 AC	$83,160	2-4	$204,000	
7) RECONSTRUCT STREAM CHANNEL							
BACKFILL EXCAVATED STREAMBED	48,400	CY	$12.00 CY	$580,800	11	$276,000	
CONSTRUCT CHANNEL BEDFORMS	29,040	LF	$4.00 LF	$116,160	11	$55,000	
CONSTRUCT TYPE 2 STREAMBANKS	23,232	FT	$8.00 FT	$185,856	11	$88,000	
CONSTRUCT TYPE 3 STREAMBANKS	23,232	FT	$51.00 FT	$1,184,832	11	$563,000	
CONSTRUCT TYPE 4 STREAMBANKS	11,616	FT	$64.00 FT	$743,424	11	$353,000	
8) SEDIMENT DETENTION ABOVE DURANT CANYON							
BASIN CONSTRUCTION	50	AF	$1,500 AF	$75,000	12	$33,000	
BASIN O & M AND SEDIMENT DISPOSAL	1	YR	$210,600 YR	$210,600	13-50	$1,234,000	
SUBTOTAL						$64,891,000	
STATE OVERSIGHT OF MONITORING DATA	1	YR	$30,000 YR	$30,000	1-50	$414,000	
SUBTOTAL						$414,000	
SUBTOTAL						$65,305,000	
CONTINGENCY @ 20%			20%			$13,061,000	
ENGINEERING AND ADMINISTRATION @ 15%			15%			$9,796,000	
TOTAL COST:ALTERNATIVE 4C							$88,580,000

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SILVER BOW CREEK - ALTERNATIVE 4C

Floodplain excavation and restoration would begin the year following issuance of the Streamside Tailings Operable Unit Record of Decision (ROD), which is anticipated in 1995. Items for floodplain work are costed for three years (1996 - 1998). Stream channel excavation and reconstruction would begin the year after remediation and restoration actions have addressed upstream waste sources. Items for stream channel work are costed for one year (2005).

1) The volume of excavated floodplain tailings will equal the total volume of floodplain tailings in the Silver Bow Creek floodplain between Colorado Tailings and Durant Canyon (1,540,000 CY), less the volume removed under remedy (430,200 CY). The final volume (1,109,800 CY) is expanded by 50% to account for the additional material unavoidably removed during waste excavation (this is based on experience with removal actions elsewhere in the Clark Fork Basin). The final volume of excavated material is 1,664,700 CY.

2a) Dewatering for streambed excavation will be accomplished by construction of a temporary bypass channel.

2b) Five and one-half miles of stream channel will be excavated. The volume of material excavated will be 64,533 CY (5.5 miles x 20' wide x 2' deep x 1.5 expansion factor).

3) Hauling costs are based on an average hauling distance of 10 miles to a disposal site. Disposal costs are based on a monofill constructed in a location near Silver Bow Creek (although existing disposal sites could be used). Hauling and disposal costs are based on the total amount of floodplain material excavated under restoration (Item I) (1,664,700 CY), plus the volume of floodplain materials excavated under remedy that had been disposed of on-site, as expanded by 50% (645,300 CY). The total volume of floodplain material that will be hauled and disposed of is 2,310,000 CY. Hauling and disposal costs for streambed sediments include those excavated under both remedy and restoration (129,067 CY).

4) Excavated areas are backfilled to recontour the floodplain and create a riparian zone, on average, 300 feet wide. The percentage is based on the percentage of floodplain that is being revegetated to a grass/forb (agricultural) habitat type (75% of the floodplain will be restored to this habitat type; the growth media cover in Item 5 will account for the remaining 25%). The amount of excavated floodplain material is 2,310,000 CY (Item 3). The amount of backfill required is 1,155,000 CY.

5) The amount of growth media is based on a 6-inch cover of 436 acres of excavated floodplain. This area is the total area of contaminated floodplain above Durant Canyon (569 acres) less the area excavated under remedy (133 acres). The volume of growth media required is 351,707 CY (436 acres x 43,560 square ft/acre x 0.5' cover).

6) Revegetation costs are based on reconstructing 436 acres of floodplain to 25% shrub/forest habitat (109 acres) and 75% grass/forbs (agricultural) habitat (327 acres). Costs include only the cost of seed and vegetation stock; labor costs are not included.

7) The amount of material needed to backfill the excavated streambed is 75% of the amount of bed material excavated (64,533 CY), or 48,400 CY. Channel bedforms (runs, riffles, and pools) are constructed during backfilling of the streambed. Streambank reconstruction costs are based on reconstruction of five and one-half miles of stream channel to 40% Type 2 banks ($8/FT), 40% Type 3 banks ($51/FT), and 20% Type 4 banks ($64/FT). The proportion of bank types is typical of a baseline condition.

8) The 50 acre-feet (AF) sediment detention basin constructed above Durant Canyon is unlined and sized to contain sediment transported during a 100-year flow event. Operation and maintenance costs include the cost of excavation, hauling, and disposal of one-tenth the volume of the basins each year. The basin would be constructed the last year of work (2006).

SILVER BOW CREEK REGION
ALTERNATIVE 4D

DESCRIPTION	QUANTITY PER YR	UNIT	UNIT COST	COST/YR 1994 DOLLARS	COST YEARS	PRESENT WORTH @ 7%*	TOTAL COST OF ALTERNATIVE
WORK ITEM DESCRIPTION							
STATE OVERSIGHT OF MONITORING DATA	1	YR	$30,000 YR	$30,000	1-50	$414,000	
TAL COST:ALTERNATIVE 4D						$414,000	

MONTANA POLE
ALTERNATIVE 5A

DESCRIPTION	QUANTITY PER YR	UNIT	UNIT COST	COST/YR 1994 DOLLARS	COST YEARS	PRESENT WORTH @ 7%*	TOTAL COST OF ALTERNATIVE
WORK ITEM DESCRIPTION							
1) REMOVE AND REPLACE HIGHWAY & BERM	1	LS	$2,106,325 LS	$2,106,000	3	$1,719,000	
2) EXCAVATE CONTAMINATED SOIL	41,000	CY	$6.00 CY	$246,000	3	$201,000	
3) HAULING	124,500	CY	$5.00 CY	$623,000	2-3	$1,053,000	
4) DISPOSAL	124,500	CY	$45.00 CY	$5,603,000	2-3	$9,468,000	
5) BACKFILL EXCAVATION							
a) HIGHWAY BERM	41,000	CY	$12.00 CY	$492,000	3	$402,000	
b) SITE AREA	208,000	CY	$12.00 CY	$2,496,000	4	$1,904,000	
6) WELL O & M	1	YR	$30,700 YR	$31,000	11-30	$167,000	
7) PROCESS O & M (0.15 MGD)	1	YR	$579,000 YR	$579,000	11-30	$3,118,000	
8) SLUDGE DISPOSAL	1	YR	$56,700 YR	$57,000	11-30	$307,000	
SUBTOTAL						$18,339,000	
STATE OVERSIGHT OF MONITORING DATA	1	YR	$30,000 YR	$30,000	1-30	$372,000	
SUBTOTAL						$372,000	
SUBTOTAL						$18,711,000	
CONTINGENCY @ 20%			20%			$3,742,000	
ENGINEERING AND ADMINISTRATION @ 15%			15%			$2,807,000	
TAL COST:ALTERNATIVE 5A							$25,260,000

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MONTANA POLE - ALTERNATIVE 5A

Work would begin in 1996, the year that actions implementing the Montana Pole Record of Decision are anticipated to begin.

1) Removal and reconstruction costs for the interstate highway and berms were estimated in 1993 by the Montana Department of Transportation. The cost assumes that approach fill material can be stockpiled at the Montana Pole site and reused. It was also assumed that the approaches would be reconstructed to their present width only, and not upgraded to federal highway standards.

2) Excavation of 41,000 cubic yards (CY) of contaminated soil under the highway berm would occur immediately after the berm is removed.

3) Hauling costs are based on hauling both the soil excavated under restoration (41,000 CY) and the 208,000 CY of soil which would have been treated and backfilled under remedy. Hauling would occur over two years (1996 - 1997), which is when excavation is projected to occur under remedy.

4) Soils would be disposed of in a RCRA subtitle C facility. Disposal would occur over two years (1996 - 1997).

5a) Clean fill (41,000 CY) would be backfilled in the area under the interstate highway during reconstruction of the highway in 1997.

5b) Clean fill (208,000 CY) would be backfilled in the area excavated under remedy in the year after excavation is complete (1998).

6) Well operation and maintenance (O & M) includes pump and valve replacement, and general maintenance such as redevelopment or cleaning of a well. O & M of the 12 wells placed in remedy would occur in years 2005-2024. This is based on the assumption that the timeframe for pumping and treating projected for remedy under the ROD (30 years) would be considerably shortened by restoration actions. Costing assumes that pumping and treating under remedy would end in 10 years (1995-2004). Pumping and treating under restoration would occur from 2005 until 2024, at which time baseline would be achieved.

7) The treatment plant size (0.15 million gallons per day) is based on the volume of groundwater to be pumped under remedy. Process plant O & M includes electricity, personnel, and replacement of equipment. O & M would occur between years 2005 - 2024 (Item 6).

8) Sludge disposal would occur in years 2005 - 2024 (Item 6). The method of disposal would be offsite incineration.

MONTANA POLE
ALTERNATIVE 5B

DESCRIPTION	QUANTITY PER YR	UNIT	UNIT COST	COST/YR 1994 DOLLARS	COST YEARS	PRESENT WORTH @ 7%*	TOTAL COST OF ALTERNATIVE
WORK ITEM DESCRIPTION							
1) REMOVE AND REPLACE HIGHWAY & BERM	1	LS	$2,106,325 LS	$2,106,000	3	$1,719,000	
2) EXCAVATE CONTAMINATED SOIL	41,000	CY	$6.00 CY	$246,000	3	$201,000	
3) BACKFILL EXCAVATION	41,000	CY	$12.00 CY	$492,000	3	$402,000	
4) TREAT CONTAMINATED SOIL	20,500	CY	$30.00 CY	$615,000	3-4	$971,000	
5) WELL O & M	1	YR	$30,700 YR	$31,000	21-50	$99,000	
6) PROCESS O & M (0.15 MGD)	1	YR	$579,000 YR	$579,000	21-50	$1,857,000	
7) SLUDGE DISPOSAL	1	YR	$56,700 YR	$57,000	21-50	$183,000	
SUBTOTAL						$5,432,000	
STATE OVERSIGHT OF MONITORING DATA	1	YR	$30,000 YR	$30,000	1-50	$414,000	
SUBTOTAL						$414,000	
SUBTOTAL						$5,846,000	
CONTINGENCY @ 20%			20%			$1,169,000	
ENGINEERING AND ADMINISTRATION @ 15%			15%			$877,000	
OTAL COST:ALTERNATIVE 5B							$7,890,000

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MONTANA POLE - ALTERNATIVE 5B

Work would begin in 1996, the year that actions implementing the Montana Pole Record of Decision are anticipated to begin.

1) Highway removal and reconstruction would proceed as described in Alternative 5A.

2) Excavation of 41,000 CY of contaminated soils under the highway will occur as described in Alternative 5A.

3) Clean fill (41,000 CY) would be backfilled in the excavated area under the interstate highway in 1997.

4) The 41,000 CY of contaminated soils will be biologically treated with the 208,000 CY of contaminated soils being similarly treated under remedy. Treating of soils removed from under the highway will occur over two years concurrent with and following removal (1997 - 1998).

5) Well operation and maintenance (O & M) includes pump and valve replacement, and general maintenance such as redevelopment or cleaning of a well. O & M of the 12 wells placed in remedy would occur in years 2015 - 2044. This is based on the assumption that the timeframe for pumping and treating projected for remedy under the ROD (30 years) would be considerably shortened by restoration actions. Costing assumes that pumping and treating under remedy would end in 20 years (1995 - 2014). Costing for pumping and treating under restoration is based on a timeframe of 2015 to 2044.

6) The treatment plant size (0.15 million gallons per day) is based on the volume of groundwater to be pumped under remedy. Process plant O & M includes electricity, personnel, and replacement of equipment. O & M for the 0.15 million gallon per day treatment plant constructed in remedy would occur between years 2015 - 2044 (Item 5).

7) Sludge disposal would occur in years 2015 - 2044 (Item 5). The method of disposal would be offsite incineration.

MONTANA POLE
ALTERNATIVE 5C

DESCRIPTION	QUANTITY PER YR	UNIT	UNIT COST	COST/YR 1994 DOLLARS	COST YEARS	PRESENT WORTH @ 7%*	TOTAL COST OF ALTERNATIVE
WORK ITEM DESCRIPTION							
1) WELL O & M	1	YR	$30,700 YR	$31,000	31-50	$43,000	
2) PROCESS O & M (0.15 MGD)	1	YR	$579,000 YR	$579,000	31-50	$806,000	
3) SLUDGE DISPOSAL	1	YR	$56,700 YR	$57,000	31-50	$79,000	
SUBTOTAL						$928,000	
STATE OVERSIGHT OF MONITORING DATA	1	YR	$30,000 YR	$30,000	1-50	$414,000	
SUBTOTAL						$414,000	
SUBTOTAL						$1,342,000	
CONTINGENCY @ 20%			20%			$268,000	
ENGINEERING AND ADMINISTRATION @ 15%			15%			$201,000	
TAL COST:ALTERNATIVE 5C							$1,810,000

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MONTANA POLE - ALTERNATIVE 5C

Restoration actions would begin after groundwater pumping and treating under remedy end in the year 2024. Costing for pumping and treating under restoration is based on a timeframe of 2025 to 2044.

1) Operation and maintenance (O & M) of the 12 wells placed under remedy includes pump and valve replacement, and general maintenance such as redevelopment or cleaning of a well.

2) The treatment plant size (0.15 million gallons per day) is based on the volume of groundwater to be pumped under remedy. Process plant O & M includes electricity, personnel, and replacement of equipment.

3) Sludge would be disposed of by offsite incineration.

MONTANA POLE
ALTERNATIVE 5D

DESCRIPTION	QUANTITY PER YR	UNIT	UNIT COST	COST/YR 1994 DOLLARS	COST YEARS	PRESENT WORTH @ 7%*	TOTAL COST OF ALTERNATIVE
WORK ITEM DESCRIPTION							
STATE OVERSIGHT OF MONITORING DATA	1	YR	$30,000 YR	$30,000	1-50	$414,000	
OTAL COST : ALTERNATIVE 5D						$414,000	

ROCKER TIMBER PLANT
ALTERNATIVE 6A

DESCRIPTION	QUANTITY PER YR	UNIT	UNIT COST		COST/YR 1994 DOLLARS	COST YEARS	PRESENT WORTH @ 7%*	TOTAL COST OF ALTERNATIVE
WORK ITEM DESCRIPTION								
1) EXCAVATE SOIL	71,440	CY	$6.00	CY	$429,000	2	$375,000	
2) HAULING	52,080	CY	$5.00	CY	$260,000	2	$227,000	
3) DISPOSAL	52,080	CY	$15.00	CY	$781,000	2	$682,000	
4) BACKFILL EXCAVATION	52,080	CY	$12.00	CY	$625,000	2	$546,000	
5a) EXTRACTION WELLS	20	WELL	$15,900	EA	$318,000	2	$278,000	
5b) WELL O & M	1	YR	$30,700	YR	$30,700	3-50	$368,000	
6a) TREATMENT PLANT CAPITAL	1	LS	$288,000	LS	$288,000	2	$252,000	
6b) PROCESS O & M (0.072 MGD)	1	YR	$277,920	YR	$278,000	3-50	$3,334,000	
7) SLUDGE DISPOSAL	1	YR	$27,216	YR	$27,000	3-50	$324,000	
SUBTOTAL							$6,386,000	
STATE OVERSIGHT OF MONITORING DATA	1	YR	$30,000	YR	$30,000	1-50	$414,000	
SUBTOTAL							$414,000	
SUBTOTAL							$6,800,000	
CONTINGENCY @ 20%			20%				$1,360,000	
ENGINEERING AND ADMINISTRATION @ 15%			15%				$1,020,000	
'AL COST:ALTERNATIVE 6A								$9,180,000

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ROCKER TIMBER PLANT - ALTERNATIVE 6A

All work at this site would occur in 1996, the year following the anticipated issuance of the Rocker Record of Decision (ROD). Operation and maintenance of the groundwater extraction and treatment system are costed through the year 2044, although the treatment plant would operate for a much longer period of time.

1) The volume of excavated soil is based on an excavation depth of 12 feet in a four acre area (77,440 CY), less 6,000 CY removed in remedy (71,440 CY). Non-contaminated soil (19,360 CY) would be stockpiled for backfilling. The volume of contaminated soil to be excavated is 52,080 CY.

2) Hauling costs are based on a 10-mile hauling distance. The volume of material hauled is 52,080 CY (Item 1).

3) Disposal costs are based on construction of a monofill in a location near Silver Bow Creek (although existing disposal sites could be used). The volume of material disposed of is 52,080 CY (Item 1).

4) The volume of clean soil is equal to the volume of excavated contaminated soil (52,080). Costs of replacing the 6,000 CY of contaminated soil excavated by remedy would be assumed by remedy.

5a) The number of wells is based on a one hundred foot spacing in the most contaminated part of the arsenic plume.

5b) Well Operation and Maintenance (O & M) includes electrical pump and valve replacement, and general maintenance such as redevelopment or cleaning of wells.

6a) Treatment plant capacity would be 0.072 million gallons per day.

6b) Process O & M includes electricity, personnel, and periodic replacement of equipment.

7) Treatment plant sludge would be disposed of by off-site incineration.

ROCKER TIMBER PLANT
ALTERNATIVE 6B

DESCRIPTION	QUANTITY PER YR	UNIT	UNIT COST		COST/YR 1994 DOLLARS	COST YEARS	PRESENT WORTH @ 7%*	TOTAL COST OF ALTERNATIVE
WORK ITEM DESCRIPTION								
1) EXCAVATE SOIL	32,720	CY	$6.00	CY	$196,000	2	$171,000	
2) HAULING	32,720	CY	$6.00	CY	$196,000	2	$171,000	
3) DISPOSAL	32,720	CY	$15.00	CY	$491,000	2	$429,000	
4) BACKFILL EXCAVATION	32,720	CY	$12.00	CY	$393,000	2	$343,000	
5a) EXTRACTION WELLS	20	WELL	$15,900	EA	$318,000	2	$278,000	
5b) WELL O & M	1	YR	$30,700	YR	$30,700	3-50	$368,000	
6a) TREATMENT PLANT CAPITAL	1	LS	$288,000	LS	$288,000	2	$252,000	
6b) PROCESS O & M (0.072 MGD)	1	YR	$277,920	YR	$278,000	3-50	$3,334,000	
7) SLUDGE DISPOSAL	1	YR	$27,216	YR	$27,000	3-50	$324,000	
SUBTOTAL							$5,670,000	
STATE OVERSIGHT OF MONITORING DATA	1	YR	$30,000	YR	$30,000	1-50	$414,000	
SUBTOTAL							$414,000	
SUBTOTAL							$6,084,000	
CONTINGENCY @ 20%			20%				$1,217,000	
ENGINEERING AND ADMINISTRATION @ 15%			15%				$913,000	
TOTAL COST:ALTERNATIVE 6B								$8,210,000

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ROCKER TIMBER PLANT-ALTERNATIVE 6B

All work at this site would occur in 1996, the year following the anticipated issuance of the Rocker Record of Decision (ROD). Operation and maintenance of the groundwater extraction and treatment system are costed through the year 2044, although the treatment plant would operate for a much longer period of time.

1) The volume of excavated contaminated soil (32,720 CY) is based on an excavation depth of 12 feet in a two acre area (38,720 CY), less 6,000 CY removed in remedy.

2) Hauling costs are based on a 10-mile hauling distance. The volume of material hauled is 32,720 CY (Item 1).

3) Disposal costs are based on construction of a monofill in a location near Silver Bow Creek (although existing disposal sites could be used). The volume of material disposed of is 32,720 CY (Item 1).

4) The volume of clean soil is equal to the volume of excavated contaminated soils (32,720 CY). Costs of replacing the 6,000 CY of contaminated soil excavated by remedy would be assumed by remedy.

5a) The number of wells is based on a one hundred foot spacing in the most contaminated part of the arsenic plume.

5b) Well Operation and Maintenance (O & M) includes electrical pump and valve replacement, and general maintenance such as redevelopment or cleaning of wells.

6a) Treatment plant capacity would be 0.072 million gallons per day.

6b) Process O & M includes electricity, personnel, and periodic replacement of equipment.

7) Treatment plant sludge would be disposed of by off-site incineration.

ROCKER TIMBER PLANT
ALTERNATIVE 6C

DESCRIPTION	QUANTITY PER YR	UNIT	UNIT COST	COST/YR 1994 DOLLARS	COST YEARS	PRESENT WORTH @ 7%*	TOTAL COST OF ALTERNATIVE
WORK ITEM DESCRIPTION							
STATE OVERSIGHT OF MONITORING DATA	1	YR	$30,000 YR	$30,000	1-50	$414,000	
TOTAL COST:ALTERNATIVE 6C						$414,000	

* YEAR ZERO IS 1994 TIME AND DATE OF PRINTOUT: 10:19 AM 18-Mar-94

UPLAND RESOURCES
ALTERNATIVE 7A

DESCRIPTION		QUANTITY PER YR UNIT	UNIT COST	COST/YR 1994 DOLLARS	COST YEARS	PRESENT WORTH @ 7%*	TOTAL COST OF ALTERNATIVE
WORK ITEM DESCRIPTION							
1) FOREST AREA REVEGETATION--60%	(4080 AC)	408 AC	$1,920 AC	$783,000	3-12	$4,803,000	
2) GRASSLAND AREA REVEGETATION--60%	(2500 AC)	250 AC	$3,000 AC	$750,000	3-12	$4,601,000	
3) O & M FOREST--60%	(4080 AC)	408 AC	$640 AC	$261,000	4-13	$1,496,000	
4) O & M GRASSLAND--60%	(2500 AC)	250 AC	$1,000 AC	$250,000	4-13	$1,433,000	
5) FOREST AREA REVEGETATION--20%	(1360 AC)	272 AC	$2,880 AC	$783,000	13-17	$1,425,000	
6) GRASSLAND AREA REVEGETATION--20%	(833 AC)	167 AC	$4,500 AC	$752,000	13-17	$1,369,000	
SUBTOTAL						$15,127,000	
STATE OVERSIGHT OF MONITORING DATA		1 YR	$30,000 YR	$30,000	1-50	$414,000	
SUBTOTAL						$414,000	
SUBTOTAL						$15,541,000	
CONTINGENCY @ 20%			20%			$3,108,000	
ENGINEERING AND ADMINISTRATION @ 15%			15%			$2,331,000	
TAL COST:ALTERNATIVE 7A							$20,980,000

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UPLAND RESOURCES - ALTERNATIVE 7A

Restoration work on Smelter Hill, Stucky Ridge, and Mount Haggin would begin in 1997, the year after the issuance of the Regional Soils Record of Decision.

1) Forest area revegetation would occur over 4,080 acres of the 10,966 acres of grossly injured area that would remain after remedy. The 4,080 acres represent the percentage of the grossly injured area that is being targeted for revegetation (60% of 10,966 acres, or 6,580 acres) and the percentage of the targeted area that should be forested (62% of 6,580 acres, or 4,080 acres). Planting would occur over a period of ten years (1997-2006). Revegetation costs include materials, labor, equipment, and terracing.

2) Grassland area revegetation would occur over 2,500 acres of the 10,966 acres of grossly injured area that would remain after remedy. The 2,500 acres represent the percentage of the grossly injured area that is being targeted for revegetation (60% of 10,966 acres, or 6,580 acres) and the percentage of the targeted area that should be grassland (38% of 6,580 acres, or 2,500 acres). Planting would occur over a period of ten years (1997-2006). Revegetation costs include materials, labor, equipment, and basin construction.

3) Operation and maintenance (O & M) costs are one-third of the cost of the initial planting. Costs include materials, labor, equipment, terrace maintenance, and weed control. O & M will occur during years 4 through 13 (1998-2007).

4) O & M costs are one-third of the cost of the initial planting. Costs include materials, labor, equipment, basin maintenance, and weed control. O & M will occur during years 4 through 13 (1998-2007).

5) Forest area revegetation would occur over 1,360 acres of the 10,966 acres of grossly injured area that would remain after remedy. The 1,360 acres represent the percentage of the grossly injured area that is being targeted for revegetation (20% of 10,966 acres, or 2,193 acres) and the percentage of the targeted area that should be forested (62% of 2,193 acres, or 1,3600 acres). Planting would occur over a period of five years (2007-2011). Due to the difficulty of revegetating this area, costs would be 50% higher than the costs for the initial revegetation.

6) Grassland area revegetation would occur over 833 acres of the 10,966 acres of grossly injured area that would remain after remedy. The 833 acres represent the percentage of the grossly injured area that is being targeted for revegetation (20% of 10,966 acres, or 2,193 acres) and the percentage of the targeted area that should be grassland (38% of 2,193 acres, or 833 acres). Planting would occur over a period of five years (2007-2011). Due to the difficulty of revegetating this area, costs would be 50% higher than the costs for the initial revegetation.

UPLAND RESOURCES
ALTERNATIVE 7B

DESCRIPTION		QUANTITY PER YR UNIT	UNIT COST	COST/YR 1994 DOLLARS	COST YEARS	PRESENT WORTH @ 7%*	TOTAL COST OF ALTERNATIVE
WORK ITEM DESCRIPTION							
1) FOREST AREA REVEGETATION--60%	(4080 AC)	408 AC	$1,920 AC	$783,000	3-12	$4,803,000	
2) GRASSLAND AREA REVEGETATION--60%	(2500 AC)	250 AC	$3,000 AC	$750,000	3-12	$4,601,000	
3) O & M FOREST--60%	(4080 AC)	408 AC	$640 AC	$261,000	4-13	$1,496,000	
4) O & M GRASSLAND--60%	(2500 AC)	250 AC	$1,000 AC	$250,000	4-13	$1,433,000	
SUBTOTAL						$12,333,000	
STATE OVERSIGHT OF MONITORING DATA		1 YR	$30,000 YR	$30,000	1-50	$414,000	
SUBTOTAL						$414,000	
SUBTOTAL						$12,747,000	
CONTINGENCY @ 20%			20%			$2,549,000	
ENGINEERING AND ADMINISTRATION @ 15%			15%			$1,912,000	
TAL COST:ALTERNATIVE 7B							$17,210,000

YEAR ZERO IS 1994 TIME AND DATE OF PRINTOUT: 09:51 AM 18-Mar-94

UPLAND RESOURCES - ALTERNATIVE 7B

Restoration work on Smelter Hill, Stucky Ridge, and Mount Haggin would begin in 1997, the year after the issuance of the Regional Soils Record of Decision.

1) Forest area revegetation would occur over 4,080 acres of the 10,966 acres of grossly injured area that would remain after remedy. The 4,080 acres represent the percentage of the grossly injured area that is being targeted for revegetation (60% of 10,966 acres, or 6,580 acres) and the percentage of the targeted area that should be forested (62% of 6,580 acres, or 4,080 acres). Planting would occur over a period of ten years (1997-2006).

2) Grassland area revegetation would occur over 2,500 acres of the 10,966 acres of grossly injured area that would remain after remedy. The 2,500 acres represent the percentage of the grossly injured area that is being targeted for revegetation (60% of 10,966 acres, or 6,580 acres) and the percentage of the targeted area that should be grassland (38% of 6,580 acres, or 2,500 acres). Planting would occur over a period of ten years (1997-2006).

3) Operation and maintenance (O & M) costs are one-third of the cost of the initial planting. Costs include materials, labor, equipment, terrace maintenance, and weed control. O & M will occur during years 4 through 13 (1998-2007).

4) O & M costs are one-third of the cost of the initial planting. Costs include materials, labor, equipment, basin maintenance, and weed control. O & M will occur during years 4 through 13 (1998-2007).

UPLAND RESOURCES
ALTERNATIVE 7C

DESCRIPTION		QUANTITY PER YR UNIT	UNIT COST	COST/YR 1994 DOLLARS	COST YEARS	PRESENT WORTH @ 7%*	TOTAL COST OF ALTERNATIVE
WORK ITEM DESCRIPTION							
1) FOREST AREA REVEGETATION--30%	(2040 AC)	408 AC	$1,920 AC	$783,000	3-7	$2,804,000	
2) GRASSLAND AREA REVEGETATION--30%	(1250 AC)	250 AC	$3,000 AC	$750,000	3-7	$2,686,000	
3) O & M FOREST--30%	(2040 AC)	408 AC	$640 AC	$261,000	4-8	$874,000	
4) O & M GRASSLAND--30%	(1250 AC)	250 AC	$1,000 AC	$250,000	4-8	$837,000	
SUBTOTAL						$7,201,000	
STATE OVERSIGHT OF MONITORING DATA		1 YR	$30,000 YR	$30,000	1-50	$414,000	
SUBTOTAL						$414,000	
SUBTOTAL						$7,615,000	
CONTINGENCY @ 20%			20%			$1,523,000	
ENGINEERING AND ADMINISTRATION @ 15%			15%			$1,142,000	
TAL COST:ALTERNATIVE 7C							$10,280,000

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UPLAND RESOURCES - ALTERNATIVE 7C

Restoration work on Smelter Hill, Stucky Ridge, and Mount Haggin would begin in 1997, the year after the issuance of the Regional Soils Record of Decision.

1) Forest area revegetation would occur over 2,040 acres of the 10,966 acres of grossly injured area that would remain after remedy. The 2,040 acres represent the percentage of the grossly injured area that is being targeted for revegetation (30% of 10,966 acres, or 3,290 acres) and the percentage of the targeted area that should be forested (62% of 3,290 acres, or 2,040 acres). Planting would occur over a period of five years (1997-2001).

2) Grassland area revegetation would occur over 1,250 acres of the 10,966 acres of grossly injured area that would remain after remedy. The 1,250 acres represent the percentage of the grossly injured area that is being targeted for revegetation (30% of 10,966 acres, or 3,290 acres) and the percentage of the targeted area that should be grassland (38% of 3,290 acres, or 1,250 acres). Planting would occur over a period of five years (1997-2001).

3) Operation and maintenance (O & M) costs are one-third of the cost of the initial planting. Costs include materials, labor, equipment, terrace maintenance, and weed control. O & M will occur during years 4 through 8 (1998-2002).

4) O & M costs are one-third of the cost of the initial planting. Costs include materials, labor, equipment, basin maintenance, and weed control. O & M will occur during years 4 through 8 (1998-2002).

UPLAND RESOURCES
ALTERNATIVE 7D

DESCRIPTION	QUANTITY PER YR UNIT	UNIT COST	COST/YR 1994 DOLLARS	COST YEARS	PRESENT WORTH @ 7%*	TOTAL COST OF ALTERNATIVE
WORK ITEM DESCRIPTION						
STATE OVERSIGHT OF MONITORING DATA	1 YR	$30,000 YR	$30,000	1-50	$414,000	
)TAL COST:ALTERNATIVE 7D					$414,000	

ANACONDA AREA
ALTERNATIVE 8A

DESCRIPTION	QUANTITY PER YR	UNIT	UNIT COST	COST/YR 1994 DOLLARS	COST YEARS	PRESENT WORTH @ 7%*	TOTAL COST OF ALTERNATIVE
WORK ITEM DESCRIPTION							
1) CAP ANACONDA PONDS							
a) SITE GRADING	233,500	CY	$6.00 CY	$1,401,000	3-4	$2,212,000	
b) FILTER FABRIC	1,350,000	SY	$0.90 SY	$1,215,000	3-4	$1,919,000	
c) 3%-5% BENTONITE LAYER	1,350,000	SY	$9.50 SY	$12,825,000	3-4	$20,253,000	
d) RANDOM FILL	451,734	CY	$ 4.00 CY	$1,806,936	3-4	$2,854,000	
e) GROWTH MEDIA	225,867	CY	$10.00 CY	$2,258,670	3-4	$3,567,000	
f) REVEGETATE POND SURFACE	280	AC	$1,500 AC	$420,000	3-4	$663,000	
g) RUNOFF COLLECTION SYSTEM	3	MI	$264,000 MI	$792,000	3	$647,000	
h) O & M FOR PONDS	1	YR	$47,000 YR	$47,000	5-50	$489,000	
i) SEDIMENT DETENTION BASIN	27	AF	$1,500 AF	$40,500	3	$33,000	
2) CAP OPPORTUNITY PONDS							
a) SITE GRADING	480,000	CY	$6.00 CY	$2,880,000	3-12	$17,668,000	
b) FILTER FABRIC	1,645,000	SY	$0.90 SY	$1,480,500	3-12	$9,082,000	
c) 3%-5% BENTONITE LAYER	1,645,000	SY	$9.50 SY	$15,627,500	3-12	$95,870,000	
d) RANDOM FILL	548,533	CY	$4.00 CY	$2,194,132	3-12	$13,460,000	
e) GROWTH MEDIA	274,266	CY	$10.00 CY	$2,742,660	3-12	$16,825,000	
f) REVEGETATE POND SURFACE	340	AC	$1,500 AC	$510,000	3-12	$3,129,000	
g) RUNOFF COLLECTION SYSTEM	11	MI	$264,000 MI	$2,900,000	3	$2,367,000	
h) O & M FOR PONDS	1	YR	$85,000 YR	$85,000	13-50	$498,000	
i) SEDIMENT DETENTION BASIN	182	AF	$1,500 AF	$273,000	3	$223,000	
SUBTOTAL						$191,759,000	
STATE OVERSIGHT OF MONITORING DATA	1	YR	$30,000 YR	$30,000	1-50	$414,000	
SUBTOTAL						$414,000	
SUBTOTAL						$192,173,000	
CONTINGENCY @ 20%			20%			$38,435,000	
ENGINEERING AND ADMINISTRATION @ 15%			15%			$28,826,000	
TAL COST:ALTERNATIVE 8A							$259,850,000

YEAR ZERO IS 1994 TIME AND DATE OF PRINTOUT: 11:12 AM 18-Mar-94

ANACONDA AREA RESOURCES - ALTERNATIVE 8A

Restoration work at the Anaconda Ponds and Opportunity Ponds would begin in 1997, the year following the issuance of the Anaconda Regional Water and Waste Record of Decision (ROD). The Anaconda Ponds would be capped over two years (1997 - 1998). The Opportunity Ponds would be capped over ten years (1997 - 2006).

1) Capping entails grading, placement of a filter fabric, placement of a bentonite layer, placement of a random fill layer, placement of growth media, and revegetation. Costing assumes that all steps would be accomplished over one-half of the 560 acres each year (280 acres per year).

a) Site grading will require moving 467,000 cubic yards (CY) of material. Grading creates a two percent slope with alternating ridges and swales that enhances surface runoff to a perimeter collection system.

b) The amount of filter fabric required for covering the ponds is 2,700,000 square yards (SY). Costs ($0.90 per SY) include purchase and installation costs.

c) The bentonite layer is comprised of fill material mixed with 3 to 5 percent bentonite. The layer will be six inches thick. Costs, at $9.50 SY, are based on the area covered (2,700,000 SY).

d) The volume of fill required for a one foot cover over 560 acres is 903,467 CY. The per unit cost ($4 CY) is based on obtaining fill locally. The borrow area will supply the fill for the bentonite layer, the fill layer, and the growth media. The borrow, which will be approximately 187 acres, will be left as wetlands habitat and will therefore not require revegetation.

e) The volume of growth media required for a 6-inch cover over 560 acres is 451,733 CY. The borrow area will be enlarged to obtain fill for the growth media. The growth media would be manufactured on-site prior to placement and would include a mixture of soil, agricultural by-products such as animal wastes, grain straw, wood chips and fertilizer.

f) The ponds will be revegetated with grasses and small shrubs following the placement of growth media. Revegetation cost is $1,500/acre.

g) The runoff collection system consists of an unlined ditch excavated around the perimeter of the ponds, and sloped to flow to one or more sediment detention basins.

h) Operation and maintenance (O & M) includes maintaining the integrity of the cap, the runoff collection system and the vegetative cover. O & M costs begin the year following completion of site grading and capping. Therefore, O & M costs during the time before the cap is completely constructed would not be captured.

i) The detention basin would not be lined because the tailings piles are capped and the runoff would not be contaminated. The basin is sized at 27 acres to collect runoff from a three and one-half inch storm or snowmelt event. Construction would occur in 1997 (the first year of site construction).

2) The Opportunity Ponds cap will be constructed in the same manner as the Anaconda Ponds cap (Item 1). Costing assumes that all steps would be accomplished in one year over approximately one-tenth of the 3400 acres each year (567 acres per year). Capping will occur over ten years (1997 - 2006).

a) Site grading will require moving 4,800,000 cubic yards (CY) of material. Grading creates a two percent slope with alternating ridges and swales that enhances surface runoff to a perimeter collection system.

b) The amount of filter fabric required for covering the ponds is 16,450,000 square yards (SY). Costs ($0.90 per SY) include purchase and installation costs.

c) The bentonite layer is comprised of fill material mixed with 3 to 5 percent bentonite. The layer will be six inches thick. Costs, at $9.50 SY, are based on the area covered (16,450,000 SY).

d) The volume of fill required for a one foot cover over 3,400 acres is 5,485,333 CY. The per unit cost ($4 CY) is based on obtaining fill locally. The borrow area will supply the fill for the bentonite layer, the fill layer, and the growth media. The borrow, which will be approximately 567 acres, will be left as wetlands habitat and will therefore not require revegetation.

e) The volume of growth media required for a 6-inch cover over 3400 acres is 2,742,667 CY. The borrow area will be enlarged to obtain fill for the growth media. The growth media would be manufactured on-site prior to placement and would include a mixture of soil, agricultural by-products such as animal wastes, grain straw, wood chips and fertilizer.

f) The ponds will be revegetated with grasses and small shrubs following the placement of growth media. Revegetation cost is $1,500/acre.

g) The runoff collection system consists of an unlined ditch excavated around the perimeter of the ponds, and sloped to flow to one or more sediment detention basins.

h) Operation and maintenance (O & M) includes maintaining the integrity of the cap, the runoff collection system and the vegetative cover. O & M costs begin the year following completion of site grading and capping. Therefore, O & M costs during the time before the cap is completely constructed are not captured.

i) The detention basins would not be lined because the tailings piles are capped and the runoff would not be contaminated. The basin is sized at 182 acres to collect runoff from a three and one-half inch storm or snowmelt event. Construction would occur in 1997 (the first year of site construction).

ANACONDA AREA
ALTERNATIVE 8B

DESCRIPTION	QUANTITY PER YR	UNIT	UNIT COST	COST/YR 1994 DOLLARS	COST YEARS	PRESENT WORTH @ 7%*	TOTAL COST OF ALTERNATIVE
ORK ITEM DESCRIPTION							
1) GRADE ANACONDA PONDS							
a) SITE GRADING	233,500	CY	$6.00 CY	$1,401,000	3-4	$2,212,000	
b) HOLDING POND	27	AF	$2,500 AF	$67,500	3	$55,000	
c) RUNOFF COLLECTION SYSTEM	3	MI	$264,000 MI	$792,000	3	$647,000	
d) RUNOFF COLLECTION SYSTEM O & M	1	YR	$15,000 YR	$15,000	5-50	$156,000	
e) TREATMENT PLANT CAPITAL (0.145 MGD)	1	LS	$580,000 LS	$580,000	4	$442,000	
f) PLANT O & M	1	YR	$70,000 YR	$70,000	5-50	$729,000	
g) SLUDGE DISPOSAL	1	YR	$121,000 YR	$121,000	5-50	$1,260,000	
2) CAP OPPORTUNITY PONDS							
a) SITE GRADING	480,000	CY	$6.00 CY	$2,880,000	3-12	$17,668,000	
b) FILTER FABRIC	1,645,000	SY	$0.90 SY	$1,480,500	3-12	$9,082,000	
c) 3%-5% BENTONITE LAYER	1,645,000	SY	$9.50 SY	$15,627,500	3-12	$95,870,000	
d) RANDOM FILL	548,533	CY	$4.00 CY	$2,194,132	3-12	$13,460,000	
e) GROWTH MEDIA	274,266	CY	$10.00 CY	$2,742,660	3-12	$16,825,000	
f) REVEGETATE POND SURFACE	340	AC	$1,500 AC	$510,000	3-12	$3,129,000	
g) RUNOFF COLLECTION SYSTEM	11	MI	$264,000 MI	$2,900,000	3	$2,367,000	
h) O & M FOR PONDS	1	YR	$85,000 YR	$85,000	13-50	$498,000	
i) SEDIMENT DETENTION BASIN	182	AF	$1,500 AF	$273,000	3	$223,000	
UBTOTAL						$164,623,000	
STATE OVERSIGHT OF MONITORING DATA	1	YR	$30,000 YR	$30,000	1-50	$414,000	
UBTOTAL						$414,000	
UBTOTAL						$165,037,000	
ONTINGENCY @ 20%			20%			$33,007,000	
NGINEERING AND ADMINISTRATION @ 15%			15%			$24,756,000	
L COST:ALTERNATIVE 8B							$223,210,000

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ANACONDA AREA RESOURCES - ALTERNATIVE 8B

Restoration work at the Anaconda Ponds and Opportunity Ponds would begin in 1997, the year following the issuance of the Anaconda Regional Water and Waste Record of Decision (ROD). The Anaconda Ponds would be graded over two years (1997 - 1998). The Opportunity Ponds would be capped over ten years (1997 - 2006).

1) The Anaconda Ponds would be covered with limestone under remedy. The grading of the ponds and construction of a runoff collection system would be coordinated with the application of limestone.

a) Site grading will require moving 467,000 cubic yards (CY) of material. Grading creates a two percent slope with alternating ridges and swales that enhances surface runoff to a perimeter collection system.

b) The 27 acre-feet (six feet deep) holding pond will be constructed in 1997, the year site construction would begin. The pond would be lined with a compacted earth liner because the Anaconda Ponds would not be capped and runoff would be contaminated with hazardous substances.

c) The runoff collection system consists of an unlined ditch excavated around the perimeter of the ponds, and sloped to flow to one or more holding ponds.

d) Operation and maintenance (O & M) of the runoff collection system includes maintaining the integrity of the runoff collection system. O & M costs begin the year following completion of site grading and capping. Therefore, O & M costs during the time before the site is completely graded would not be captured.

e) The treatment plant would have a capacity of 0.145 million gallons per day, based on the volume of water collected from a three and one-half inch storm or snowmelt event (162 acre-feet).

f) Treatment plant O & M include water quality monitoring, electricity, general upkeep, periodic replacement of equipment, and personnel costs. The treatment plant would be constructed in 1998, the year following initial site grading.

g) Sludge disposal costs begin the year following construction of the treatment plant, and extend to the year 2044.

2) Capping of the Opportunity Ponds would occur over ten years (1997 - 2006), as described in Alternative 8A.

ANACONDA AREA
ALTERNATIVE 8C

DESCRIPTION	QUANTITY PER YR	UNIT	UNIT COST	COST/YR 1994 DOLLARS	COST YEARS	PRESENT WORTH @ 7%*	TOTAL COST OF ALTERNATIVE
WORK ITEM DESCRIPTION							
1) GRADE ANACONDA PONDS							
a) SITE GRADING	233,500	CY	$6.00 CY	$1,401,000	3-4	$2,212,000	
b) HOLDING POND	27	AF	$2,500 AF	$67,500	3	$55,000	
c) RUNOFF COLLECTION SYSTEM	3	MI	$264,000 MI	$792,000	3	$647,000	
d) RUNOFF COLLECTION SYSTEM O & M	1	YR	$15,000 YR	$15,000	5-50	$156,000	
e) TREATMENT PLANT CAPITAL (0.145 MGD)	1	LS	$580,000 LS	$580,000	4	$442,000	
f) PLANT O & M	1	YR	$70,000 YR	$70,000	5-50	$729,000	
g) SLUDGE DISPOSAL	1	YR	$121,000 YR	$121,000	5-50	$1,260,000	
2) GRADE OPPORTUNITY PONDS							
a) SITE GRADING	800,000	CY	$6.00 CY	$4,800,000	3-8	$19,984,000	
b) HOLDING POND	182	AF	$2,500 AF	$455,000	3	$371,000	
c) RUNOFF COLLECTION SYSTEM	11	MI	$264,000 MI	$2,904,000	3	$2,371,000	
d) RUNOFF COLLECTION SYSTEM O AND M	1	YR	$55,000 YR	$55,000	9-50	$431,000	
e) TREATMENT PLANT CAPITAL (1 MGD)	1	LS	$4,000,000 LS	$4,000,000	4	$3,052,000	
f) PLANT O & M	1	YR	$484,000 YR	$484,000	5-50	$5,040,000	
g) SLUDGE DISPOSAL	1	YR	$837,000 YR	$837,000	5-50	$8,716,000	
SUBTOTAL						$45,466,000	
STATE OVERSIGHT OF MONITORING DATA	1	YR	$30,000 YR	$30,000	1-50	$414,000	
SUBTOTAL						$414,000	
SUBTOTAL						$45,880,000	
CONTINGENCY @ 20%			20%			$9,176,000	
ENGINEERING AND ADMINISTRATION @ 15%			15%			$6,882,000	
AL COST:ALTERNATIVE 8C							$62,350,000

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ANACONDA AREA RESOURCES ALTERNATIVE - 8C

Restoration work at the Anaconda Ponds and Opportunity Ponds would begin in 1997, the year following the issuance of the Anaconda Regional Water and Waste Record of Decision (ROD).The Anaconda Ponds would be graded over two years (1997 - 1998). The Opportunity Ponds would be graded over six years (1997 - 2002).

1) The Anaconda Ponds would be graded and covered as described in Alternative 8B.

2) Grading and covering of the Opportunity ponds would occur in years 1997-2002. The Opportunity Ponds would be covered with limestone under remedy. The grading of the ponds and construction of a runoff collection system would be coordinated with the application of limestone.

a) Site grading will require moving 4,800,000 cubic yards (CY) of material. Grading creates a two percent slope with alternating ridges and swales that enhances surface runoff to a perimeter collection system.

b) The 182 acre-feet (six feet deep) holding pond will be constructed in 1997, the year site construction would begin. The pond would be lined with a compacted earth liner because the Opportunity Ponds would not be capped and runoff would be contaminated with hazardous substances. The pond is sized to collect runoff from a three and one-half inch storm or snowmelt event. Construction would occur in 1997 (the first year of site construction).

c) The runoff collection system consists of an unlined ditch excavated around the perimeter of the ponds, and sloped to flow to one or more holding ponds.

d) Operation and maintenance (O & M) of the runoff collection system includes maintaining the integrity of the runoff collection system. O & M costs begin the year following completion of site grading and capping. Therefore, O & M costs during the time before the site is completely graded would not be captured.

e) The treatment plant would have a capacity of 1 million gallons per day, based on the volume of water collected from a three and one-half inch storm or snowmelt event (1,090 acre-feet).

f) Treatment plant O & M include water quality monitoring, electricity, general upkeep, periodic replacement of equipment, and personnel costs. The treatment plant would be constructed in 1997, the year after site grading begins.

g) Sludge disposal costs begin the year following construction of the treatment plant, and extend to the year 2044.

ANACONDA AREA
ALTERNATIVE 8D

DESCRIPTION	QUANTITY PER YR	UNIT	UNIT COST	COST/YR 1994 DOLLARS	COST YEARS	PRESENT WORTH @ 7%*	TOTAL COST OF ALTERNATIVE
WORK ITEM DESCRIPTION							
STATE OVERSIGHT OF MONITORING DATA	1	YR	$30,000 YR	$30,000	1-50	$414,000	
TAL COST:ALTERNATIVE 8D						$414,000	

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CLARK FORK RIVER
ALTERNATIVE 9A

DESCRIPTION	QUANTITY PER YR	UNIT	UNIT COST	COST/YR 1994 DOLLARS	COST YEARS	PRESENT WORTH @ 7%*	TOTAL COST OF ALTERNATIVE
WORK ITEM DESCRIPTION							
1) EXCAVATE FLOODPLAIN TAILINGS	353,843	CY	$6.00 CY	$2,123,000	6-13	$9,039,000	
2) REMOVE RIVERBANKS	80,190	CY	$6.00 CY	$481,000	6-9	$1,162,000	
3) HAULING AND DISPOSAL							
HAULING OF FLOODPLAIN TAILINGS	353,843	CY	$5.00 CY	$1,769,000	6-13	$7,531,000	
DISPOSAL OF FLOODPLAIN TAILINGS	353,843	CY	$15.00 CY	$5,308,000	6-13	$22,599,000	
HAULING OF RIVERBANK MATERIALS	80,190	CY	$5.00 CY	$401,000	6-9	$968,000	
DISPOSAL OF RIVERBANK MATERIALS	80,190	CY	$15.00 CY	$1,203,000	6-9	$2,905,000	
4) BACKFILL FLOODPLAIN	105,125	CY	$12.00 CY	$1,262,000	6-9	$3,048,000	
5) GROWTH MEDIA COVER	84,095	CY	$10.00 CY	$841,000	6-9	$2,031,000	
6) REVEGETATE FLOODPLAIN							
SEED AND MULCH GRASSES/FORBS	552	AC	$825 AC	$455,000	6-13	$1,937,000	
HAND PLANT SHRUBS/TREES	21	AC	$2,310 AC	$49,000	6-9	$118,000	
7) RECONSTRUCT RIVERBANKS							
CONSTRUCT TYPE 1 STREAMBANKS (50%)	32,076	FT	$0.00 FT	$0	6-9	$0	
CONSTRUCT TYPE 2 STREAMBANKS (20%)	12,830	FT	$8.00 FT	$103,000	6-9	$249,000	
CONSTRUCT TYPE 3 STREAMBANKS (20%)	12,830	FT	$51.00 FT	$654,000	6-9	$1,579,000	
CONSTRUCT TYPE 4 STREAMBANKS (10%)	6,415	FT	$84.00 FT	$539,000	6-9	$1,302,000	
8) FLOW AUGMENTATION	54,298	AF	$42.00 AF	$2,281,000	10-50	$16,618,000	
SUBTOTAL						$71,086,000	
STATE OVERSIGHT OF MONITORING DATA	1	YR	$30,000 YR	$30,000	1-50	$414,000	
SUBTOTAL						$414,000	
SUBTOTAL						$71,500,000	
CONTINGENCY @ 20%			20%			$14,300,000	
ENGINEERING AND ADMINISTRATION @ 15%			15%			$10,725,000	
TAL COST:ALTERNATIVE 9A							$96,530,000

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CLARK FORK RIVER - ALTERNATIVE 9A

Restoration work will begin the year following issuance of the Clark Fork River Operable Unit Record of Decision (ROD). The ROD is anticipated in the year 1999. Excavation of floodplain tailings will begin in 2000.

1) The volume of excavated material is based on the volumes of Complex I tailings (841,000 cubic yards (CY)) and Complex II tailings (2,004,000 CY). Under remedy, tailings immediately adjacent to the river channel would be pulled away from the river channel and redeposited on devegetated floodplain areas further away. It is anticipated that this would occur only in Complex I areas. This action under remedy would have no effect on the calculation of the volume of Complex I tailings excavated. Remedy will not address Complex II areas. Complex II tailings within 10 feet of the river channel would be excavated as part of the riverbank removal. This volume of tailings is 14,256 CY (Item 2). Therefore, the total volume of Complex II tailings is reduced by 14,256 CY to calculate floodplain excavation costs. The volume of excavated floodplain material is based on the volume of Complex I tailings (841,000 CY) and the adjusted volume of Complex II tailings (1,989,744 CY). The final volume of material is 2,830,744 CY (841,000 CY plus 1,989,744 CY) and is excavated over 8 years (2000 - 2007).

2) Riverbanks between Warm Springs and Deer Lodge that are located in floodplain areas mapped as Complex I and Complex II tailings would be removed and reconstructed. Approximately 90% of the banks in this reach are in such areas. Based on a reach length of 27 miles, an excavation width of 10 feet, and a bank height of 4 feet, 380,160 CY of material would be excavated (27 miles x 2 banks x .9 x 5280'/mile x 10' width x 4' bank height). One-half of the excavated riverbanks are estimated to be in the Complex I area, and one-half are estimated to be in the Complex II area. Therefore, the 380,160 CY of excavated bank material would contain 59,400 CY of Complex I tailings (27 miles x 1 bank x .9 x 5280'/mile x 10' width x 1.25' tailings thickness) and 14,256 CY of Complex II tailings (27 miles x 1 bank x .9 x 5280'/mile x 10' width x 0.3' tailings thickness). Under remedy, 59,400 CY of material would be pulled away from the river and redeposited on the floodplain further away from the river. For costing bank excavation, the total volume of bank material (380,160 CY) is reduced by 59,400 CY. Riverbanks will be removed over four years (2000 - 2003).

3) Hauling costs are based on an average distance of 10 miles to a disposal site. Disposal costs are based on construction of a monofill in a location near the Clark Fork River (although existing disposal sites could be used). Excavated riverbed materials are hauled and disposed of in years 2000 - 2003. Excavated floodplain materials are that are excavated under Item 1 are hauled and disposed of in years 2000 - 2007. Hauling and disposal costs for floodplain and riverbank materials are based on the volumes excavated under Items 1 and 2 (2,830,744 CY and 320,760 CY, respectively).

4) Complex I floodplain areas, which contain the thickest tailings deposits, would be backfilled with clean material. The amount of backfill would be 50% of the volume excavated. This amount is 420,500 CY (50% of 841,000 CY). Backfilling will occur over four years (2000 - 2003).

5) The amount of growth media is based on a 6-inch cover of 417 acres of excavated Complex I floodplain, or 336,380 CY (417 acres x 43,560 square ft/acre x 0.5' cover). The cover would be applied over four years (2000 - 2003).

6) Revegetation costs are based on restoring 400 acres of riparian resources to 25% shrub/forest habitat (100 acres) and 75% grass/forbs (agricultural) habitat (300 acres), less the area of floodplain revegetated in conjunction with riverbank reconstruction (Item 7). Riverbank reconstruction will revegetate approximately 59 acres of floodplain (27 miles x 2 banks x 90% x 5280'/mile x 10' width /43,560 square feet per acre). Revegetation on these 59 acres will contribute to restoration of riparian resources. Therefore, 15 acres will be shrub/forest habitat type and 44 acres will be grass/forb habitat type. Costs for floodplain revegetation will therefore be based on 85 acres of shrub/forest habitat and 256 acres of grass/forb habitat. The remaining 4157 acres would be revegetated to existing conditions. For costing purposes, it was assumed that these 4157 acres have a grass/forb vegetative cover type. Costs include only the cost of seed and

vegetation stock; labor costs are not included. Shrub/forest revegetation would occur over the first four years of floodplain excavation (2000 - 2003). Grass/forb revegetation would occur over eight years of floodplain excavation (2000 - 2007).

7) Costs are based on reconstruction of 256,608 feet of riverbanks between Warm Springs and Deer Lodge. Riverbanks will be reconstructed to 50% Type 1 banks ($0/FT), 20% Type 2 banks ($8/FT), 20% Type 3 banks ($51/FT), and 10% Type 4 banks ($84/FT). Riverbank reconstruction will restore habitat on 59 acres of floodplain. Banks would be reconstructed during the first four years of restoration work.

8) The amount of water necessary to augment flows in the Clark Fork River by 100 cubic feet per second for nine months of the year is 54,298 acre-feet. This water would be acquired at the market price of $42.00 per acre/foot. The cost is incurred annually beginning the year after completion of riverbank reconstruction (2004). The cost is held constant over time, although water prices could rise substantially.

CLARK FORK RIVER
ALTERNATIVE 9B

DESCRIPTION	QUANTITY PER YR	UNIT	UNIT COST	COST/YR 1994 DOLLARS	COST YEARS	PRESENT WORTH @ 7%*	TOTAL COST OF ALTERNATIVE
WORK ITEM DESCRIPTION							
1) EXCAVATE FLOODPLAIN TAILINGS	260,350	CY	$6.00 CY	$1,562,000	6-9	$3,772,000	
2) HAULING AND DISPOSAL							
HAULING OF FLOODPLAIN TAILINGS	260,350	CY	$5.00 CY	$1,302,000	6-9	$3,144,000	
DISPOSAL OF FLOODPLAIN TAILINGS	260,350	CY	$15.00 CY	$3,905,000	6-9	$9,431,000	
3) BACKFILL FLOODPLAIN	105,125	CY	$12.00 CY	$1,262,000	6-9	$3,048,000	
4) GROWTH MEDIA COVER	84,095	CY	$10.00 CY	$841,000	6-9	$2,031,000	
5) REVEGETATE FLOODPLAIN							
SEED AND MULCH GRASSES/FORBS	183	AC	$825 AC	$151,000	6-9	$365,000	
HAND PLANT SHRUBS/TREES	25	AC	$2,310 AC	$58,000	6-9	$140,000	
6) REVEGETATE RIVERBANKS	32,076	FT	$0.25 FT	$8,000	6-9	$19,000	
7) FLOW AUGMENTATION	54,298	AF	$42.00 AF	$2,281,000	10-50	$16,618,000	
SUBTOTAL						$38,568,000	
STATE OVERSIGHT OF MONITORING DATA	1	YR	$30,000 YR	$30,000	1-50	$414,000	
SUBTOTAL						$414,000	
SUBTOTAL						$38,982,000	
CONTINGENCY @ 20%			20%			$7,796,000	
ENGINEERING AND ADMINISTRATION @ 15%			15%			$5,847,000	
TOTAL COST:ALTERNATIVE 9B							$52,630,000

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CLARK FORK RIVER - ALTERNATIVE 9B

Restoration work will occur over four years following the issuance of the Clark Fork River Operable Unit Record of Decision (ROD). The ROD is anticipated in the year 1999. All work items, except where noted, are costed over four years (2000 - 2003).

1) The volume of excavated floodplain material is based on the volumes of Complex I tailings (841,000 cubic yards (CY)) and 10% of the volume of Complex II tailings (200,400 CY). Under remedy, tailings immediately adjacent to the river channel would be pulled away from the river channel and redeposited on devegetated floodplain areas further away. It is anticipated that this would occur only in Complex I areas. This action under remedy would have no effect on the calculation of the volume of Complex I tailings excavated. Remedy will not address Complex II areas. The final volume of excavated material is 1,041,400 CY (841,000 CY plus 200,400 CY).

2) Hauling costs are based on an average distance of 10 miles to a disposal site. Disposal costs are based on construction of a monofill in a location near the Clark Fork River (although existing disposal sites could be used).

3) Complex I floodplain areas, which contain the thickest tailings deposits, are backfilled with clean material. The amount of backfill would be 50% of the amount excavated. This amount is 420,500 CY.

4) The amount of growth media is based on a 6-inch cover of 417 acres of excavated Complex I floodplain, or 336,380 CY (417 acres x 43,560 square ft/acre x 0.5' cover).

5) Revegetation costs are based on restoring 400 acres of riparian resources to 25% shrub/forest habitat (100 acres) and 75% grass/forbs (agricultural) habitat (300 acres). The remaining 431 acres would be revegetated to existing conditions. For costing purposes, it was assumed that these 431 acres have a grass/forb vegetative cover type. Costs include only the cost of seed and vegetation stock; labor costs are not included.

6) Riverbanks would be stabilized by revegetating with shrubs. Shrubs would be planted in the bank immediately next to the stream channel. Bank revegetation would occur on banks not stabilized under remedy. The estimated length of riverbank stabilized under remedy is 128,304 feet (27 miles x 2 banks x .9 x 5280'/mile x .5). This corresponds to the estimated length of riverbanks within or along Complex I tailings. This is also the approximate length of riverbank in or adjacent to Complex II floodplain areas. The cost of bank stabilization is based on the cost per square foot of revegetating one acre of floodplain to shrub/forest habitat ($2,310 per acre, or about five cents per square foot). It was assumed that shrubs would be planted over five square feet for each lineal foot of stabilized bank.

7) The amount of water necessary to augment flows in the Clark Fork River by 100 cubic feet per second for nine months of the year is 54,298 acre-feet. This water would be acquired at the market price of $42.00 per acre/foot. The cost is incurred annually beginning the year after completion of riverbank stabilization (2004). The cost is held constant over time, although water prices could rise substantially.

CLARK FORK RIVER
ALTERNATIVE 9C

DESCRIPTION	QUANTITY PER YR	UNIT	UNIT COST	COST/YR 1994 DOLLARS	COST YEARS	PRESENT WORTH @ 7%*	TOTAL COST OF ALTERNATIVE
WORK ITEM DESCRIPTION							
STATE OVERSIGHT OF MONITORING DATA	1	YR	$30,000 YR	$30,000	1-50	$414,000	
TAL COST:ALTERNATIVE 9C						$414,000	

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